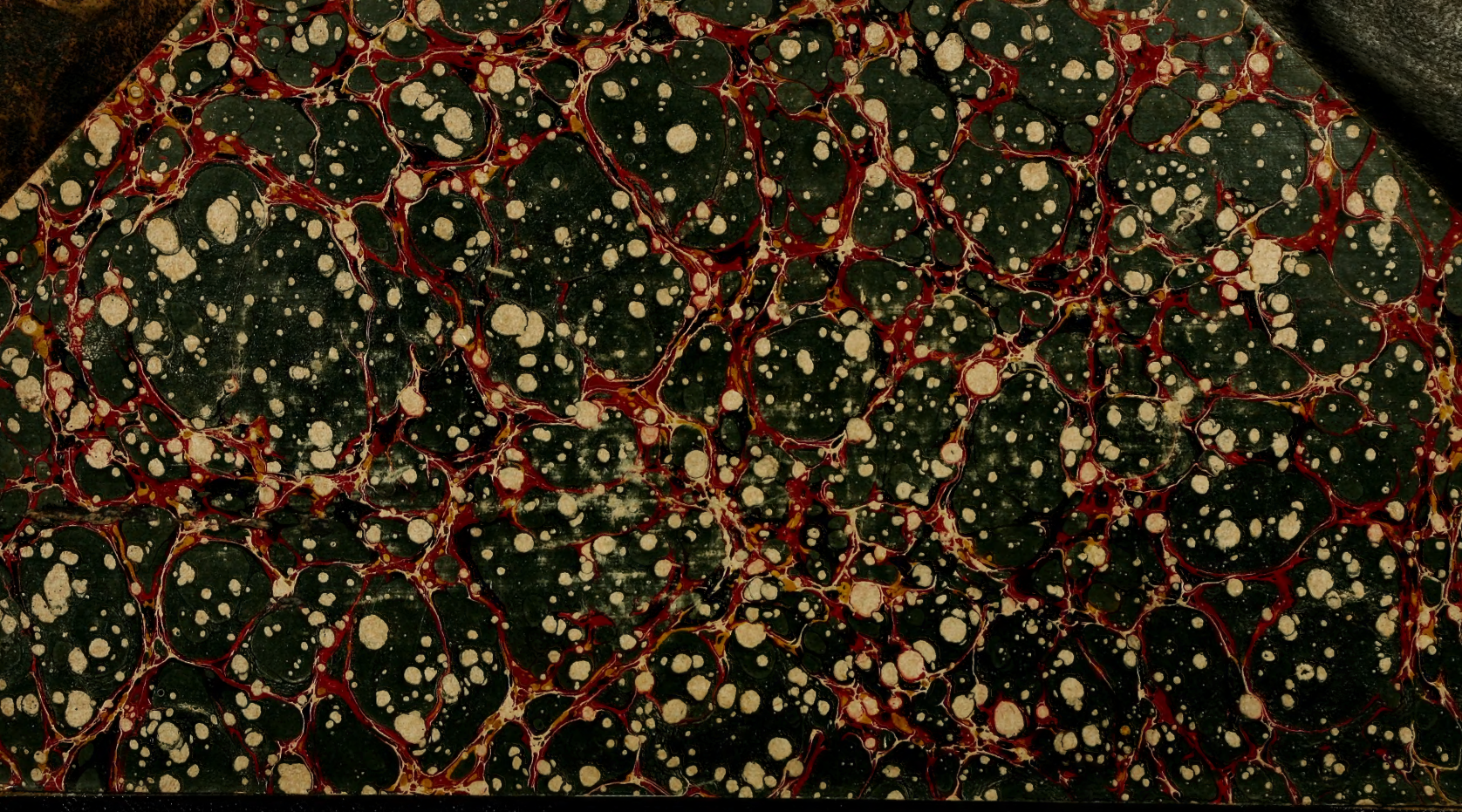

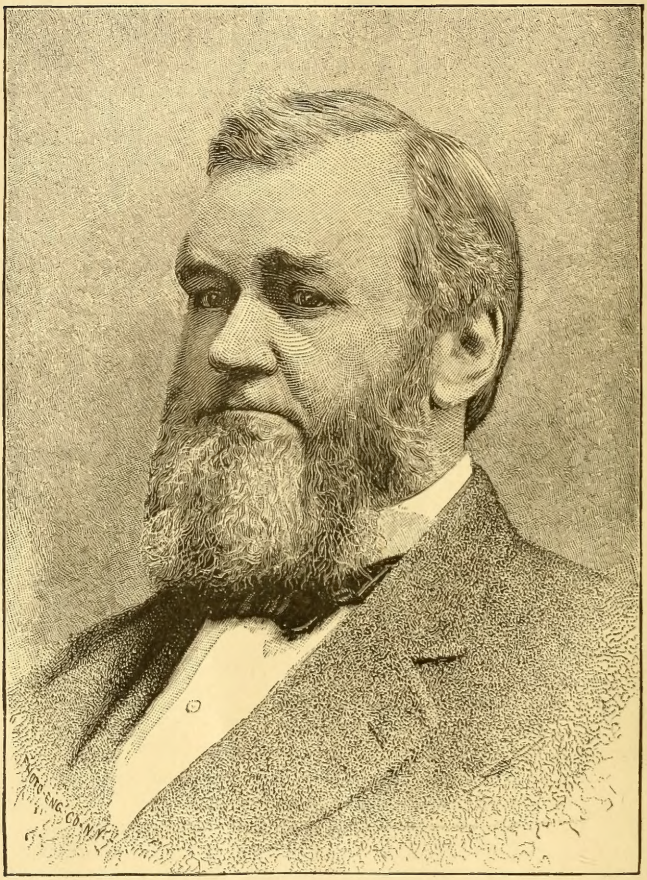

S. F. Baird.

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Memorial to Spencer Fullerton Baird, LL. D.

By CHAS. W. SMILEY.

WASHINGTON, D. C.

On Wednesday evening, January 11, 1888, a meeting was held in the lecture-room of Columbian University, Washington, D. C., in commemoration of the life and services to science of the late Professor Baird, Secretary of the Smithsonian Institution, Director of the National Museum, and United States Commissioner of Fish and Fisheries. The exercises were under the auspices of the Philosophical Society of Washington in conjunction with the Anthropological Society, the Biological Society, the Chemical Society, and the Microscopical Society.

The opening address was by Garrick Mallery, President of the Philosophical Society. The address upon Professor Baird as administrator was by William B. Taylor, of the Smithsonian Institution. The address upon Professor Baird in science was by William H. Dall, President of the Biological Society. The address upon the personal characteristics of Professor Baird was by John W. Powell, President of the Anthropological Society. Professor Baird was much interested in all the above-named societies.

The addresses will soon be published in full. It is hoped that a biography may be prepared by one who appreciated him as no other could. Many public prints record the important events of his life. Congress is apparently about to provide for a bronze statue similar to that of Henry in the Smithsonian grounds. The writer may, perhaps, be permitted to contribute a few personal reminiscences indicative of the character of the man.

If one quality was more prominent in his life than others it was his kindness. He had as kind words for messenger boys as for Senators. He never showed that he felt superior to anybody, and he always appeared to prize the friendship and cordiality of those whom everybody knew to be his inferiors. What often surprised me was that he would spend valuable time in entertaining those who had no such claims upon him. Some book, picture, specimen, letter, or incident was generally handy to furnish him a text for charming conversation. Some came at length to feel, after his health began to fail, that they ought not to let him use his time thus, for he surely would atone for it in over-work; and so, not compelled by business to confer with him for several days, when one endeavored to lessen the multitude of interviews he was holding, the Professor noticed the absences, and playfully rallied the absentee upon his omissions, as if the former, and not the latter, had been the loser thereby. Whoever came into his friendship came to stay, and he never deserted any in adversity, even when they became troublesome to him.

I never saw him at all angry, and, upon catechising one of his most constant attendants upon this point, the most I could learn was that on one occa-

sion, when a beautifully bound book dropped into the mud, virtually ruining it, the Professor uttered some mild by-word. When a man came at him with a storm of abuse or of misapprehensions, he would sit perfectly quiet until the storm had spent itself and the bearer had said all he could think of, then in the calmest manner he replied so kindly as always to send his antagonist away happy. His kindness extended to wrong-doers and unfaithful employees. He was never known to discharge from the service for incompetency or neglect any person whom he had known personally. When it became evident that one was not doing well, the Professor would try the person in some other capacity. There are those who have thus made very extended rounds in search for their proper spheres.

Certain of his subordinates were inclined to quarrel and to appeal to him, but he could never be drawn into their controversies. He never administered reproof, as such, though he sometimes talked of giving an offender 'a wigging.' His gentle suggestions were, however, a sufficient reproof to those who could profit by them. He sometimes wrote letters, which he considered a reproof, but even these usually got torn up before they reached the mails. He always tried to provide for the relatives of those who died or became disabled in the service. He could see hope for the shiftless and drunken when all the rest of us gave them up and demanded their dismissal. Once it was said concerning an offender:—'Well, Prof. Baird has not backbone enough to dismiss him.' To which the latter replied when it came to his ears:—'No, Prof. Baird has not backbone enough to be harsh with one who is unfortunate.' Strangely, too, he did not seem in the least offended that such a reflection had been passed upon him by one of his most trusted associates. His kindness was sometimes put to severe strain by thick-skinned people, who had found out to what lengths they could go. At times it was pitiful to see his generosity and forbearance so imposed upon by schemers seeking only their own aggrandizement. The presentation of certain people's cards was often a warning that an office-seeker or a complainer was to be seen. Should he drop some great interest for fifteen minutes for an interview useless to him? 'Oh, dear!' he would sometimes say, and drop his work; but by the time he reached his caller he was serene and even cordial. No one ever knew him well but to love him.

Next to kindness may be placed his modesty. As it permeated everything, there could be no suspicion of affectation. Even his dress, always neat, was so unostentatious that he was often likened in appearance to a well-to-do farmer. His horse and carriage were the plainest that could be seen at the Smithsonian or the White House. He was granted the privileges of the floor in the Senate and the House, but he never exercised them. He did not like to dine out with foreign ministers and Government officials, though his rare powers of conversation and his official position would have made him doubly welcome there. He was exceedingly averse to appearing in public meetings. I never saw him on a public platform but once, and he stipulated then that he must not be called upon nor mentioned. When he attended the National Academy or the American Association he would usually be seen in the lobby rather than in the sessions. He refused the presidency of the latter society at the Portland meeting from his aversion to standing before assemblies. When asked if he would attend various celebrations to which he was invited, he generally replied: 'What do you suppose they would care for my presence?' Of all the tickets which he received to stage seats on great occasions, and free seats for great events, he used scarcely one per cent. He attended neither church nor theatre for a dozen years. Barnum's circus was the one only large gathering which he loved to frequent. 'I don't care what the rest of you do; I am going to the circus this afternoon,' he exultingly exclaimed

one day a few summers ago. The way he threw off care that day was grand. He never courted the favor of the President, Senators, or Congressmen, and he felt so unequal to paying them the attention he considered them to deserve that he sometimes tried to delegate the task. And yet the intermediaries, whom the Professor evidently considered very important, as I have been told, were regarded by the legislators only as so many errand boys.

A third characteristic of mark was his habits of economy. Until past the age of fifty he never indulged in what he called 'the luxury of a stenographer.' His office and fittings were plain. The money at his disposal went a great way so long as he could control its expenditure. In late years, when there were two hundred persons under his control, he had to allow them some extravagances. As between kindness and economy the former prevailed. 'Yes, Mr. S.,' he said one day, 'that lot of blanks will cost seventy-five dollars. You and I would rule a few sheets of foolscap which would answer just as well *for us;* but our friend will not be happy till he has the blanks, and so you will have to get them for him.' And then to offset the extravagances of such men he would economize elsewhere. Scientists are reputed to be lacking in financial ability. This man was not, and he leaves his family in very comfortable circumstances.

To me the calmness with which he at last faced the inevitable was amazing. For months he knew his condition and the progress of his disease even better than his physicians. Quietly he arranged his estate, selected his successors in all three institutions, gave certain confidential directions in the interest of his family, but he tried to conceal from them his expected departure. There was no crucifix, no priest, no religious ceremony, no tears, no murmur, no farewell. Only when he had gone was it discovered to what marvellous perfection he had brought his business arrangements. Only then did we learn many things that had been his secrets for months. To my mind even death quailed before him, and, as had occurred so often in his life, so this last visitor, which came as an enemy, melted into a friend. All was calm, peaceful, and sublime.

Rhizopoda; their life-history and classification.*

By Rev. FREDK. B. CARTER.

MONTCLAIR, N. J.

The Rhizopoda are most interesting objects of study, for several reasons. First, because of their universality, since they are found everywhere:—on the mountains, in the valleys, at the bottom of the ocean, far away in the most distant regions, and right at one's own door. Wherever there is moisture, be it only so slight as that which gathers in the moss clinging to the dripping rock or growing between the flagstones on our walks, there one is almost sure to come upon these little creatures. The nearest pond, the smallest ditch will yield them. Therefore, one need never be at a loss for want of material, while each new locality visited during a summer vacation or an occasional and temporary ramble will add to his treasures. Again, they are interesting because of their distribution in time, existing as they have done from a very early age of the earth's history to the present day. 'No other division of the animal kingdom,' says an authority,† 'can equal in this respect some of this class,' and 'it may even be said that all other fossils are modern by comparison.' They appeal to us, also, because of the important

* Abridged from a paper read before the Essex Co. (N. J.) Microscopical Society, Nov. 2, 1887.
† Carpenter, *Ency. Brit.* Art., Foraminifera.

part they play in nature, owing to their immense numbers. The sediment of the Atlantic ocean is largely composed of their shells, which form 97 per cent. of the ooze.* Paris is almost built up of them; likewise, the Pyramids of Egypt. The European chalk and the green sands of our own country are chiefly formed of their remains. In the island of Barbadoes rock strata of the tertiary period, 1,100 feet in thickness, are full of the same. 'They form the chief component of a limestone band, often 1,800 miles in breadth, and frequently of enormous thickness, that may be traced from the Atlantic shores of Europe and Africa through Western Asia to Northern India and China, and likewise over vast areas of North America.'† But perhaps no better idea of their enormous numbers can be given than by stating the results of several counts or estimates by different observers. D'Orbigny counted 6,000 individuals in an ounce of sand from the Adriatic, and estimated that there were 160,000 in a gramme of selected sand from the Antilles. Schultze found 1,500,000 in 15 grammes of sand from the coast of Sicily. Leidy obtained over 38,000 to the ounce at Atlantic City.‡

Furthermore, they cannot fail to attract because of the beautiful and varied shapes which they display. Some of the most exquisite of all microscopic objects belong to this class. And not only the shells themselves, but their delicate markings command attention, being fully as fascinating as those on the diatoms which have so monopolized the time and patience of all lovers of the tube. But over and above all these points there is an absorbing interest attaching to the Rhizopods because of their place in the natural scale. They are the lowest of all animal forms. In studying them we are studying life at its very foundation. If there is any truth in evolution, we are here at the first round of the ladder. Thus, geographically, chronologically, geologically, æsthetically, and biologically, my subject has claims upon you all.

What, then, are the Rhizopods? They are 'a class of the animal sub-kingdom Protozoa,'§ ranking below the worms and the rotifers, below the polyps and the jelly-fish, below even the infusoria—'animals, because they depend on preformed protoplasm, and do not possess a cellulose cell-wall; protozoans, because not differentiated into cells.'‖ Mark that latter point, for thus it will be seen that they are not only the last of several subdivisions; they are on one side and all other animals whatsoever on the other. The Protozoa and the Metazoa are to-day the two most noticeable divisions of the animal kingdom, the former being 'either single cells, or aggregates of similar cells corresponding to the mulberry stage of higher types, the latter being individualized organisms, every part of which contributes to the life of the whole,'¶ the mulberry mass developing into parts mutually dependent.

Such are Rhizopods, systematically speaking; but when you ask me to describe them anatomically I am at a loss. In most animals it is the complexity of structure that puzzles one, but in these it is the very opposite. The simplicity is so great that there is positively almost nothing to mention. When I have told you that they are bits of jelly, that they have an outside and an inside, a spherule of protoplasm more distinct than the rest, and a vesicle which appears and disappears, I have said all there is to be said. You may call the outside the ectosarc and the inside the endosarc, but that is only to substitute Greek for English terms. Except that the inside is more granular than the outside, there is no difference. 'The exoplasm and endoplasm,' says Lankester, 'described in amœbæ, &c., by some authors, are not distinct layers, but one and the same continuous substance—what was internal at one moment becoming external at another, no really structural differ-

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* Carpenter, *The Microscope*, p. 569. † *Idem*, p. 580. ‡ Leidy, Rhizopods.
§ *Mic. Dict.* ‖ M'Alpine, Biol. Atlas. ¶ Carpenter, *The Microscope.*

ence existing between them.'* Furthermore, to call the solid particle the nucleus does not add much to our knowledge, because it is far from being such in any true sense. Positively the only thing that approaches an organ is the contractile vesicle, which apparently plays a part in excretion. This is the strange feature of the Rhizopods; they have no organs or members of any kind; no mouth, no stomach, no feet, no tentacles, no anything. They are merely structureless protoplasm; and when they want feet or tentacles they let some portion of the body flow out in root-like processes, from which characteristic, indeed, they derive their name, the Rhizopoda or root-footed. And yet these structureless creatures can do all that any higher animal can do with all its organs; for they move, they capture and devour prey, they take in and assimilate food, they grow, they build up shells of exquisite beauty, and they reproduce their kind. Thus they are perfect anomalies, enough to puzzle all who study them. Here you have protoplasm at once at its simplest and its best, and a very wonderful substance it is seen to be, with chemical properties most diverse, producing a denser kind of itself, as it were, as in the nucleus, and depositing 'membranes of pure chitin . . . or shells of pure calcium carbonate or quasi-crystalline needles of silica.'† How it can perform all these various functions—move, seize, eat, digest, grow, and reproduce its kind—without organs of any kind, without even muscle or nerve, is the mystery of mysteries of biology. And here let me remark that the essential part of all the Rhizopods *is this protoplasmic substance*. I emphasize this point because it is likely to be overlooked by the novice. What strikes one particularly in very many of the species is the shell or membrane, and the beginner is almost sure to regard that as the prominent feature. On the contrary, the shell goes for nothing, so far as the whole class is concerned, it being free and entirely separable from the cell-protoplasm.‡ It is the *substance within the shell* that is of paramount importance, and this substance is absolutely the same throughout all the members of the group. The protoplasm and the contractile vesicle, therefore, are the only two features of which we really need to take notice in the study of these forms, for the exact nature of the nucleus is still under discussion, it being doubtful whether it is identical with the nucleus of tissue-forming cells.

Concerning the first, then, protoplasm, the most prominent characteristic is its motion. This is of a streaming or flowing nature, and is best seen in Amœba. The whole mass is in a state of ceaseless movement. And this leads to external change of shape as well as internal circulation. In the vegetable cell the bounding cell-wall prevents any variation of form, and the protoplasm travels round and round the inner side of the investing membrane; but in the naked rhizopod there is no cell-wall, properly speaking, and the protoplasm pushes out in every direction, followed by a streaming of the more granular and fluid contents. Thus *Amœba proteus* is never the same in shape for any length of time. Try to draw it, and before you have finished it is altered in outline. It goes creeping along, this way and that, and suddenly there is a bulging out of the hyaline boundary which quickly lengthens into a finger-like process, or pseudopod, into which the granular portion streams with greater or less activity as the case may be. But even while this is going on, *another pseudopod* may have formed in the opposite direction, and now the protoplasm flows back into that. If an 'animalcule' or a desmid comes in contact with one of these pseudopods others are quickly put out on that side of the body, as a fisher might cast his lines, and these gradually close round the prey in such wise as to form a temporary stomach. Digestion at once begins, and after all the nutriment has been assimilated the protoplasm

* *Ency. Brit.*, Protozoa. † *Ency. Brit.*, Protozoa. ‡ *Ency. Brit.*, Protozoa.

flows on and leaves the refuse behind. At times of seizure the activity of the flow is greatly increased, and there is no more wonderful sight than that of an amœba engaged in surrounding its prey. It seems to be almost conscious, so deftly does it complete its work. In the Heliozoa, however, the change of form is mainly confined to the protrusion or retraction of the rays, the body mass remaining quite constant. In the shelled protoplasts it is still further restricted by the chitinous or siliceous test, so that the pseudopods are put forth from one definite part of the whole, the so-called mouth or opening in the shell. But even then these processes never remain the same long. They increase in length or are retracted; they vary in width or in direction, becoming angular instead of straight, or curved, or twisted on themselves. A reticular structure is said to have been demonstrated in the protoplasm of Lithamœba, and Lankester says it is not improbable that a reticular differentiation of the general protoplasm similar to that of the nucleus may be found to exist in all cells.

Turning now to the contractile vacuole, the first point is to distinguish it from other vacuoles, permanent or gastric. The permanent vacuoles contain water or special chemical secretions of the protoplasm, such as oil drops or deposits of solid consistence. The gastric vacuoles are due to the taking in of water with the solid particles of food. But the contractile vacuole is very different in character and function. 'It may be seen to burst,' says the author just quoted, 'breaking the surface of the protozoan and discharging its liquid contents to the exterior; its walls, formed of undifferentiated protoplasm, then collapse and fuse. After a short interval it re-forms by slow accumulation of liquid at the same or a neighboring spot in the protoplasm. The liquid is separated at this point by an active process taking place in the protoplasm which probably is of an excretory nature, the separated water carrying with it nitrogenous waste-products. A similar active formation of vacuoles containing fluid is observed in a few instances (*Arcella*, some Amœbæ) when the protoplasm separates a gas instead of liquid, and the gas vacuole so produced appears to serve a hydrostatic function.'*

One more point remains to be considered in regard to the life-history of the Rhizopods, namely reproduction. Concerning this little is positively known. Division is the most common mode, and this may be in a greater or less degree. We may have two parts, as in Amœba, or many, as in *Arcella*. Spores, amœboid, or flagellate, have also been observed. Carpenter cites Prof. Edwards as authority for such 'swarm-spores,' which swim about like infusoria, in the case of Amœba.† Leidy ‡ says that 'from the researches of Mr. Carter it would appear that in Amœba and Euglypha, representatives of the Lobose and Filose Protoplasts, the endosarc becomes resolved into nucleated cells, which are of the nature of ova, while the nucleus is resolved into granuliferous, non-nucleated cells, finally breaking up into their constituent granules, which are of the nature of spermatozoids.' Leidy figures Arcella in pairs and surmises these to be cases of conjugation; but I am inclined to believe that some of these are rather instances of the formation, by division, of new individuals from the parent cells; for it is noteworthy that the individuals differ in size, in color, and in the character of the shell, some having almost none at all. However, one of the authors in the *Mic. Dict.* asserts positively that he has seen Arcella in conjugation. Leidy figures also a number of nearly colorless individuals of Arcella, which I believe to be young forms in process of development, the shell not yet having been secreted or being of very delicate texture. In this view I am supported by the writer in the *Mic. Dict.* just quoted. He adds that the shell is cast several times before arriving

* *Ency. Brit.*, Protozoa. † *The Microscope.* ‡ Rhizopods.

at maturity, and Leidy cites Clarapéde and Lachmann as vouching for the same fact. The green mass in Heleopera is probably a collection of spores. For illustrations of these points the student is referred to Leidy's work on Rhizopods, plate xxxv, showing three successive views of the same pair of individuals in so-called conjugation; also plates xxxiii, xxix, xxvii, and especially plate xxxix, fig. 25, which is almost a demonstration that the process is not conjugation, but simple division. See also plate xl for division of *Actinophrys*, and plate xliv for *Clathrulina* and young. Carpenter may also be consulted with advantage. See pp. 470, 471 for reproduction of *Protomyxa* and *Vampyrella*, which though now ranked still lower than the Rhizopods are so close to them (differing only in the absence of a nucleus, and even that is said to have been found in Vampyrella) that they may lead us to infer the like process for the higher members of the Protozoa. See also p. 479 for reproduction of Microgromia, and p. 485 for that of Clathrulina by a different process from that figured in Leidy. But the whole subject is as yet very imperfectly understood, and it is a point toward which the observer may well direct his attention. There is a chance here to make most important discoveries, and every one who studies the Rhizopods should make this a special object of his investigations. The great difficulty I find to be the lack of a perfect growing slide. I have tried several forms, but they are all unsatisfactory, and one is obliged to trust to luck—to a happy observation just at the right time. I have had splendid specimens of *Heleopera* under observation lately, in which the spore-case was unusually well developed; I have even seen the protoplasm protruded and one or two of the green granules with it, the protoplasm assuming spherical form with the granules inside; I have seen what appeared to be the spore-cases after they had been entirely set free from the shell; and if I had only had a proper growing slide I feel sure the development might have been easily watched. If therefore any one can help me in this line I shall take it as a favor.

Having thus touched upon the main points of the life-history, we come now to the classification, concerning which the authorities are not agreed. Carpenter makes three divisions, the *Mic. Dict.* four, Leidy five, while Lankester, in his magnificent article on the Protozoa in the last edition of the *Ency. Brit.*, and Huxley also, in his article on the Animal Kingdom, in the same work, propose a system in which the Rhizopods as a distinct class find no place, neither 'local habitation nor a name.' But, as this latter system is very recent and much more intricate, and is frankly confessed to be merely tentative, I have thought it best to confine myself to the older method, as being more serviceable to us, since we are much more likely to have at hand the works of the former three authorities. And if we leave out the last division of Leidy, as Carpenter has done, making the Monera a distinct class of the sub-kingdom Protozoa, we shall find that these three authorities are virtually in agreement, thus:—The Reticularia of Carpenter = the Foraminifera of the *Mic. Dict.* and Leidy; the Heliozoa of Carpenter = the Radiolaria of the Micrographic and the Heliozoa, and Radiolaria of Leidy; while the Lobose of Carpenter and the *Mic. Dict.* = the Protoplasta of Leidy. And since Leidy is our great American authority, and the one most likely of all to be studied by any of us, I have given his classification the preference, omitting the last division, so that we have these four orders:—

I. The Protoplasta.
II. The Heliozoa.
III. The Radiolaria.
IV. The Foraminifera.

These four fall again into two main subdivisions, founded on locality, namely, the fresh-water and the marine Rhizopods; the Protoplasta and the

Heliozoa forming the first, the Radiolaria (represented mainly by the Polycistina) and the Foraminifera forming the second section. It would carry us too far to enter into the minor classifications of the marine Rhizopods, but the fresh-water forms require more extended notice, as they constitute what are generally meant by the term; what, I take it, we are all most interested in as objects of study and discussion; and what, I presume, the members of this society expected to be described in a paper on this subject. Therefore, simply begging you to bear carefully in mind that the Foraminifera and the Polycistina are just as truly Rhizopods as the fresh-water forms commonly suggested by the name, I pass on to the latter.

The fresh-water Rhizopods then fall, as we have seen, into two groups — the Protoplasta and the Heliozoa. But of these, the former is much the larger, and also the more important, systematically considered. For while, under the head of the Heliozoa, or sun-animalcules, Leidy describes some 8 genera (excluding Vampyrella, which is now placed by Carpenter in a still lower division of the Protozoa) under the head of the Protoplasta he enumerates 22. Again, all those 8 have such a marked feature in common that when one has seen one he may be said to have seen all; at least, he would have no difficulty in *placing* any of them at once. A glance at the names suffices to show this, thus:—

Actinophrys, Heterophrys, Raphidiophrys, Diplophrys, Actinosphærium, Acanthocystis—that is to say, all these are characterized by *radiating filaments* from all parts of the body. *Actinophrys sol*, therefore, the common sun-animalcule, needs only to be well studied to familiarize the observer with this whole order, the 8 *genera* of which are founded upon the *peculiar form* of the rays. Furthermore, one of these, Clathrulina, is the only fresh-water rhizopod which bears a stem, and Hyalolampe is so rare that it need not be taken into account. The order is thus practically reduced to the 6 genera mentioned, so far as the student is concerned, all of which, as we have said, may be recognized at once; while as to the distinct genus, rays forked, not forked, diverse, long and needle-shaped, or extending in tufts from two orifices,—these are all the points necessary to bear in mind to distinguish respectively Acanthocystis, Actinophrys, or Actinosphærium, Heterophrys, Raphidiophrys, and Diplophrys.

Thus you will see that the study of the Rhizopods, as regards minute classification, narrows down to the study of the first order only. The Foraminifera and the Radiolaria may be omitted as *marine*, and therefore better fitted for separate investigation; and the Heliozoa are so similar as to occasion no difficulty.

We come then to the Protoplasta as *the* order of all four which especially demands our consideration, because it is greatest in the number of genera, and because these genera present such wide diversity of form.

Here, again, Leidy makes a division which helps us not a little, by separating the protoplasta into two sub-orders, namely, the Lobosa and the Filosa, the former with blunt finger-like processes, the latter with thread-like processes of great delicacy. Under the head of Lobose Protoplasts we have 13 genera, of Filose Protoplasts 9. Let any one then look at the shape of the pseudopods as they are extended from the body of the creature, and he will be able to rule out at once either 13 or 9 of the genera, as the case may be. Supposing that he has thus succeeded in localizing his specimen in the Lobose sub-group, there is another point which will simplify the identification still further. Has the creature a *shell* or not? If not, he may exclude 8 of the 13 genera of this division, and place it confidently among the first 5, all of which are amœboid in character and readily distinguished, namely:—*Amœba*, *Ouramœba*, *Dinamœba*, *Pelomyxa*, *Hyalodiscus*. Of the whole five Amœba

is the type, and the knowledge of this one will lead to that of the other four.

If, on the other hand, a *shell* is present, then there are 8 genera to be considered, namely; *Difflugia*, *Hyalosphenia*, *Quadrula*, *Nebela*, *Heleopera*, *Arcella*, *Centropyxis*, *Cochliopodium*.

Look now to the *character* of the shell. Is it formed of large sand-grains? It is a *Difflugia* or a *Centropyxis*, and the position of the so-called mouth or opening, whether inclined or not inclined, will determine between them. Is it formed of square plates? It is a *Quadrula*. Are the markings round or oval, like a mass of eggs, or round and rod-like, intermingled like a piece of mosaic? It is a *Nebela*. Finely punctate, the dots resolving into hexagons under a higher power? It is an *Arcella*. 4, 5, or 6 sided, the sides formed of beads? It is an *Heleopera*. Is the shell smooth or scalloped at the edges while being oval in form? It is an *Hyalosphenia*. Lastly, does the shell invest the creature like a membrane, and exhibit at the circumference dots in cross-lines like those of a diatom? It is a *Cochliopodium*. Thus we have disposed of the 13 genera belonging to the Lobose group.

And the Filose division may be mastered with equal ease. Here are only 9 genera instead of 22 to begin with, and the generic characteristics are distinct and readily remembered. The list is as follows: *Pamphagus*, *Pseudodifflugia*, *Cyphoderia*, *Campascus*, *Euglypha*, *Placocista*, *Assulina*, *Trinema*, *Sphenoderia*. Of these, three may be recognized at once:—*Cyphoderia* by its shape, that of a retort; *Euglypha* by its large hexagonal plates and serrated mouth; and *Assulina* by its scales, like those on a butterfly's wing. *Trinema* has an inclined pouch-like shell. In *Sphenoderia* the plates are round or oval, arranged in alternating rows, and often intersecting. *Campascus* has a couple of horns to the shell. *Placocista* is a thorny sphenoderia. *Pamphagus* has a flexible investing membrane, often folded in one part or another; and *Pseudodifflugia* is a difflugia with filose instead of lobose pseudopods.

This will make it clear, I think, that the study of the rhizopods is not so formidable as a glance at Leidy's huge volume would incline the tyro to imagine. Of course you will understand that the key suggested, which has been drawn from Leidy's illustrations, is by no means exhaustive. It will not settle all forms, but it will enable the beginner to determine the great majority; will give him such a start that he can afterwards push the matter by the aid of Leidy's splendid monograph. It is the first step which costs, and there is nothing that will more discourage the student than to be met at the outset by an elaborate series of descriptions, or even by an involved analysis of the genera. What is needed is that the work should be simplified to the last degree, the most salient features alone being pointed out, so that he may be encouraged to proceed by feeling that he is making progress. This has been my object, and I shall hope to convince you, by means of diagrams, that it is possible to become acquainted with the different genera in a very easy way.

But before concluding the paper let me say a word or two about a few other points connected with this study.

First, about the size of these objects. They are very minute, and the plates in Leidy's work will be almost sure to mislead, even though one use the power he appends to the descriptions. Thus some specimens of *Difflugia pyriformis* are only $\frac{1}{400}$th inch in length; of *nebula*, $\frac{1}{500}$th; of *Arcella vulgaris*, $\frac{1}{500}$th; of *Assulina*, $\frac{1}{1000}$th; of *Trinema*, $\frac{1}{1600}$th. Of these, *Difflugia* may be met with as large as $\frac{1}{4}$th inch, but the others will not run above $\frac{1}{200}$th. And the breadth, except in the case of *Arcella*, is *much less*. Amœba varies still more, from $\frac{1}{7}$th to $\frac{1}{2600}$th inch. I repeat, therefore, that

Leidy's illustrations will be almost sure to mislead. After looking at his figure of *Amœba proteus*, you go hunting around on the slide for a cannon-ball, when you ought to be on the watch for the finest shot. I remember, when it was first pointed out to me, I couldn't help exclaiming, in some disgust, Is that an Amœba ? It seemed utterly insignificant alongside the mammoth illustration. Expect them, then, to seem minute and trifling, and remember to put on a good high power before you pass over anything that bears any resemblance to a rhizopod. Especially will this be needed when you set to work to determine the genus, the lines and markings of the shell being very delicate in many cases. It may do to use the binocular and the $\frac{1}{2}$-inch for a Difflugia, but when it is a Nebela or an Assulina, you want the monocular tube, the $\frac{1}{5}$th or the $\frac{1}{8}$th objective, and central illumination of the very best kind.

Next, about collecting the specimens. Begin with the best habitat of all, and that is sphagnum, or bog-moss. You will get more forms out of a sphagnum swamp than from half a dozen other localities. And they will be clean and nice; and if the moss is just put in a candy jar with some of the bog-water, and covered with a glass plate to exclude the dust, they will keep in good condition for months if not exposed to the direct rays of the sun. *But you won't find the forms in all sphagnum.* If at first you don't succeed, however, do as the proverb directs. *Keep at the sphagnum*, gathering it from other localities, until your search is rewarded, as it surely will be. And if you can't find any sphagnum, go to any florist in the city and buy some. They almost always have it on hand, and from such a quarter I got most beautiful specimens of *Hyalosphenia papilio* years ago, finer than I have ever found since. The moss was in an old barrel in the florist's yard, where it had lain for weeks, yet many of the rhizopods were alive. It will please you to learn that that sphagnum came from New Jersey.

Lastly, as to preserving and mounting. Carbolized water makes an excellent medium, a few drops of the strongest solution being added to a six or eight-ounce bottle of material, and the whole thoroughly shaken. The rhizopods may then be mounted directly on a slide, without any cell, the cover being fastened down by successive rings of Brown's cement, or a thin cell of this cement may be made first, and the cover applied as before.

The Rhizopods, therefore, are so easily obtained, kept, preserved, and mounted; they are so beautiful and diverse; and they offer so many points of interest that the subject is a most fascinating and profitable one for the microscopist; and I trust that this brief and imperfect sketch may be the means of inducing all of you to engage in this study at some time or other. Whether you discover anything new or not, you will surely be repaid for all the labor you may put upon them.

The staining of animal and vegetable tissues.*—I.

By ARTHUR J. DOHERTY,

MANCHESTER, ENGLAND.

SINGLE-STAINING.

The object of the present paper, which is addressed to professed biologists as well as to *dillettanti*, is twofold:—firstly, to record the results of my own extensive researches into the properties of staining reagents; and, secondly, to place before the microtomist, in a condensed form, an account of various

* Reprinted from Transactions of Manchester Microscopical Society, 1886.

processes adopted by other workers with the microscope. Nevertheless, it must not be supposed that every stain and every process of staining recently introduced into histology will be here described; the space at my command is too limited to enable me to perform so stupendous a task, nor should I do so if it were otherwise. In contradistinction to some writers, I cannot help thinking that during the last two or three years the subject of staining has been rather overdone; and I venture to believe that the processes which I am about to detail, or modifications of these processes, will be found to admit of a wide application, and that anyone possessing a knowledge of them will be able to solve any problem in staining with which he may be confronted in practical biological science.

The art of staining tissues for microscopic examination may be advantageously discussed under two heads, viz., single-staining and double or multiple-staining. The first of these, involving only simple processes, and being the only method known to and practised by the early histologists, is most properly treated of first.

A recent writer, Arthur Bolles Lee, treats us, in his 'Microtomist's Vade-Mecum,' to what appears to me to be a somewhat original notion as to the purpose for which staining reagents are employed. Under the head of 'Theory of Staining' (page 38) he says:—'The chief ends for which coloring reagents are employed in zoo-histology is to obtain a *nuclear* stain of tissues, that is, a stain in which nuclei, or, at most, the nuclei and their surrounding cell-protoplasm are colored, whilst the formed material of the tissues is left unstained. That is what the histologist wants in the great majority of cases. He wants either to differentiate the intimate structure of cells by means of a color reaction, in order to study them for their own sake, or he wants to have the nuclei of tissues marked out by staining in the midst of the unstained formed material in such a way that they form landmarks to catch the eye, which is then able to follow out with ease the contours and relations of the elements to which the nuclei belong; the extra-nuclear parts of these elements being expressly left unstained, in order that as little light as possible may be absorbed in passing through the preparation. Diffuse stains, or those which stain formed material as well as protoplasm, are now more and more abandoned; for instance, eosin, which was once a favorite stain, is now but little used on account of the incorrigible diffuseness with which it stains. Except for special purposes, such as the dyeing of thin membranes, which unstained would be invisible, or for certain purely chemical ends, or for combination with a nuclear stain to make a double-stain, diffusely-staining coloring agents are not employed.'

Whilst admitting that the study of the germinal matter of cells is an important part of animal histology, I certainly cannot indorse Mr. Lee's tacit theory that it is the chief branch of that science. Furthermore, it would be instructive to learn how or by what means the eye can 'follow out with ease the contours and relations of the elements to which the nuclei belong,' when those elements are left unstained, and are therefore invisible in most mediums. Surely microscopic preparations in which, 'at most,' the nuclei and their surrounding cell-protoplasm were stained would be utterly worthless, except for the one special and *not* most important purpose, the study of the development of the living matter of the cell. What the animal histologist really wants, in the majority of cases, is by a single stain, or a combination of stains, to mark out clearly and sharply the particular characters of both formed and forming tissue material, and the relation of different structures one to another; then, and then only, is he in a position to understand the purposes which tissues serve, or the use for which they are intended, in the living body.

Foremost and most important of all staining reagents is logwood; it is easy to prepare and use, and is equally serviceable for coloring the tissues either of animals or plants; and, moreover, the dye is absolutely permanent.

Logwood is the popular English name given to the tree and the wood of *Hæmatoxylon campechianum*, of Central America, and the aqueous stain is best prepared in the following manner:—A quantity of logwood chips is macerated in cold water for forty-eight hours, the water being changed once or twice during the process. This treatment removes the tannic acid present in the wood, and although a quantity of color also comes away a much larger amount remains behind. Boiling water is poured over the chips, and the solution is then evaporated down until a deep yellowish-brown liquid is obtained. This portion is poured off, and when it is quite cold two or three pieces of potash alum and ten per cent. of strong methylated spirit are added, and the whole is well shaken up. The stain tends to become stronger by exposure to the atmosphere for a few days; it should always be filtered immediately before use. Sections which are to be stained with logwood must not contain a trace either of any acid or of alcohol; the former would inevitably destroy the color of the stain, and the latter would cause the dye to be precipitated in a finely granular form. Chromic or nitric acid preparations must, therefore, before being stained, be neutralized by passing the sections through a strong solution of bicarbonate of soda, and washing them afterwards in water; and sections of tissues that have been hardened, or kept in alcohol, must be deprived of any spirit which they may contain by soaking them for an hour in water.

Place the objects in the extract, either diluted or undiluted, and as soon as they are sufficiently stained wash them in water, and preserve them in glycerin until they are required. It is better, however, to mount objects immediately after they have been stained, rather than delay the process. Logwood preparations may be mounted in glycerin, glycerin jelly, Farrant's medium, dammar, or balsam; but tissues which are to be mounted in the two last-named media should be more deeply stained than for the others.

Sections of brain and spinal cord should invariably be put through the following processes *before being stained* with logwood:—1st, thoroughly dehydrate the sections by soaking them one hour in 90% alcohol; 2d, clear them in oil of cloves; 3d, place them in rectified benzine for forty-eight hours, changing the benzine thrice during that time; 4th, wash out the benzine with 90% alcohol; 5th, remove the alcohol by soaking the sections in water; 6th, and finally, for fear that the benzine employed may have contained a trace of nitric acid, neutralize with a solution of bicarbonate of soda; the sections are then washed and stained in the usual manner. It will be found that the nerve elements are stained a rich and beautiful violet, which is absolutely permanent.

For staining tissues in bulk, previous to slicing with the sliding or other microtome, which produces sections altogether too thin to be afterwards put through the process of staining, Kleinenberg's alcoholic Hæmatoxylin is specially serviceable, as its penetrating power is considerably higher than that of the ordinary aqueous solution of logwood.

(To be continued.)

The Death of Professor Oscar Harger, at New Haven, Conn., on Nov. 6th, deprives zoology of one of its most able and enthusiastic supporters.

For many years Professor Harger has been the chief assistant of Prof. O. C. Marsh, and much of the valuable palæontological work from under the direction of Professor Marsh has come from the personal study of Prof. Harger. In addition to this, Prof. Harger had attained rank as perhaps the best American authority on the systematic study of isopods, in spite of delicate health for many years, and has been taken from his work while still a young man.

Works on fresh-water algæ accessible in Washington.*

By Prof. E. S. BURGESS.

WASHINGTON, D. C.

The object of this paper is to direct notice to the facilities now existing in and near Washington for the study of the fresh-water algæ, with the hope of enlisting the interest of new workers, and of securing greater facilities.

Attention is called to the slow development of algological science in this country, and to its beginning in the Old World, finding its first formulated expression in Vaucher's History of the Fresh-water Algæ, in 1803. Works devoted to descriptions of fresh-water algæ, of which copies are known to be in Washington, arranged according to date of publication or preparation, are as follows, including references to those accessible at Baltimore :—

1845. Hassall's British Fresh-water Algæ ; now become a rare book. The only copy known in this section is that of the Library of Congress ; two volumes, the first containing text, the second plates ; valuable to the student of development of the science, and to the general student for comparison ; but its terminology, classification, indefinite modes of description, and the author's mental attitude, all furnish a curious contrast to more recent science. Nothing can impress on us more forcibly a sense of the advantages of the student of the present day than to turn back to this ambitious, extended, and once authoritative work, and to see recorded there the vain struggles of the science of that time to comprehend or correlate structures now regarded as fundamental. The amount of labor that has been required to establish the truths of cell-structure will hardly be appreciated until, in this volume, the student reads the acute author's confessions of uncertainties and his doubts as to the interpretation of phenomena.

1845. Kützing's Phycologicæ Tabulæ commenced publication this year, continuing till 1869. These volumes of plates of the then known algæ of the world have been very serviceable in identification of species ; a copy is in the Peabody Library, Baltimore. They must be used with the remembrance that the author was inclined to multiply species, great numbers of which have since been disallowed. But his names, even in such cases, are useful as badges by which to label states, conditions, or varieties, which may often be as important to study as are distinct species. Unfortunately no copy of his preceding text, 'Phycologia Generalis,' 1843, is at hand.

1850. Microscopical Observations in Several Southern States, by Prof. J. W. Bailey, of the West Point Academy, published by the Smithsonian, contains, among other objects, a number of figures and descriptions of desmids ; out of print ; copies are occasional.

1850. Harvey's 'Nereis,' published by the Smithsonian, contained descriptions and colored figures of a number of our fresh-water species (together with the marine, which constitute its bulk) ; out of print ; copies occasional, and in principal libraries ; sold at $20.00.

1864. Rabenhorst's Flora Europæa Algarum. We look in vain in this section for a copy of this great work, long an authority, and the basis of Prof. Wood's North American Fresh-water Algæ. Some specimens of Rabenhorst's 'Algæ Exsiccati' are, however, in the herbarium of the Agricultural Department. Nos. 521–540 are in the Library of Congress.

1872. Wood's North American Fresh-water Algæ ; copies occasional, and in principal libraries ; sold at $5.00. Till now the only American monograph on the subject ; contains descriptions of 375 species ; many measurements given, but not in fractions of a micromillimeter ; a number of colored figures.

*Abstract of paper read before the Washington Microscopical Society, Nov. 8, 1887.

Mounts of algæ accompanying its preparation were deposited by Prof. Wood in the Army and Navy Medical Museum.

1874. Reinsch: Contributiones ad Algologiam et Fungologiam. One copy, in the Johns Hopkins University Library, in Latin: quarto; including a larger number of marine species than of fresh-water; with numerous colored figures of poor quality: useful for comparison, and with descriptions of some North American species.

1885. Cooke's British Fresh-water Algæ: one (imperfect) copy in Peabody Library, Baltimore; sold at $22.00: with many colored figures; measurements in fractions of a micromillimeter: good descriptions and excellent explanatory notes: dates of foundation of genera given, a feature other scientific works should copy.

1885. A manuscript abstract of the preceding work was exhibited, made by E. S. Burgess in the spring of 1885, and, as a synopsis, very helpful in identification and comparison of our species.

1885. Wolle's Desmids of the United States: the speaker's copy exhibited; two copies in Fish Commission Library: a monograph for which praise is almost superfluous: one of the crowning glories of American science, and made readily useful for identification by the Analytic Key, by Dr. A. C. Stokes, published in *The American Microscopical Journal* June–Sept.,'86.

1885. Preliminary List of Algæ Observed in the District of Columbia, by Edw. S. Burgess; MS. exhibited.

1885. Algæ Exsiccati of the District of Columbia, by Edw. S. Burgess; preliminary volume of card mounts exhibited, displaying the appearance in mass of 105 specimens illustrating 45 of the larger species.

1885–6. Hitchcock's Provisional Key to the Classification of the Fresh-water Algæ; in *The American Microscopical Journal.*

1887. Wolle's Fresh-water Algæ of the United States. The speaker exhibited his copy, the first copy printed; commending its admirable descriptions, for their number, 1300 species, and numerous measurements in fractions of a micromillimeter: excellent mechanical execution; admirable illustrations, faithful and explicit; a number of good synopses of genera; so great a success that it seems almost ungracious to mention its faults, which are principally the lack of general analytic keys to family and genus characters, and the tendency to suppress or unduly shorten the treatment of unicellular algæ. A copy has recently been added to the U. S. National Museum Library.

An abundance of unicellular algæ is within easy reach of us; particularly the extensive growth of *Protococcus viridis* on trees and walls, just brightened and vigorous from recent rains, especially on the Smithsonian building. Charts illustrating its growth have been prepared. Specimens of this and of young water-nets, cladophoras, and other algæ are shown in bottled masses, and by the microscope.

MICROSCOPICAL TECHNIQUE.

Staining of Koch's bacillus.*

Dr. B. Frankell proposes the following formulæ and methods:—3 cc. anilin oil are dissolved in 7 cc. alcohol (or 1.5 cc. toluidin in 8.5), and added to 90 cc. of distilled water; to 100 parts of this, 11 parts of a saturated watery solution of methyl-violet or fuchsin (Weigert). To prepare a solution fresh for use Frankell heats about 5 cc. of anilin or toluidin to boiling in a test-tube, and pours it into a watch-glass. To this hot solution the alcoholic solution of

* *Journal of the Royal Microscopical Society* for 1885, p. 557.

the dye is added drop by drop, until a deep opalescent color, but no precipitate, is produced. Cover-glass specimens of bacteria, floated on this hot solution, are stained in two minutes.

The following solutions are used for contrast staining:—

1. *Blue.*—Alcohol, 50; water, 30; nitric acid, 20; as much methyl-blue as is dissolved by shaking.

2. *Brown.*—Alcohol, 70; nitric acid, 30; as much vesuvin brown as will dissolve.

3. *Green.*—Alcohol, 50; water, 20; nitric acid, 30; as much malachite or methyl-green as will dissolve.

The cover-glasses are stained in these solutions for 1–2 minutes, washed in water or 1 per cent. acetic acid, and then in 50 per cent. alcohol and dried (firstly between folds of blotting paper, and then by passing them several times through a flame). In this way one can obtain a perfectly double-stained specimen in four minutes.

EDITORIAL.

American Microscopes.—There is perhaps no article of American manufacture which has not some one to oppose it upon the ground that foreign articles are better. We hear this of optical goods, and the erroneous notion goes out that all foreign microscopes are better than those of American make. That this idea in its general application is incorrect is patent to most persons who compare the articles. But for a certain prestige which belongs to foreign goods people would often select the more convenient home-made article. Take an example from our personal observation in the line of lithological microscope stands. The new instrument of Bausch & Lomb or the stand of Mr. W. H. Bulloch will bear very close comparison in all the departments of the mechanism for special lithological work with the stand of Voight & Aschgesung—the stand which is regarded as the best. For a specialist it is sometimes necessary to employ the foreign stand in order to secure some peculiar device it may have, but the majority of users are not specialists. The disadvantages of foreign stands, apart from any æsthetic consideration against the forms adopted by German makers, begin to be felt when one imports directly, and must endure loss of time, higher cost, and the vexation consequent on the details of custom-house business, even if the delicate goods themselves suffer no injury from the careless handling of inexpert inspectors. And they continue to be felt whenever there is any break or injury which ought to receive attention from the maker but cannot because of his inaccessibility. The same is felt in a lesser degree whenever inquiries occur which would be referred to the manufacturer if he were near at hand.

We believe that better objectives for a given sum and for some studies are made in Germany than in England, France, or America, but we do not believe that our best American goods are, in any respect, inadequate to the work required of them. In our American designs for stands, accessories, and most of our lesser optical utensils, we are greatly in advance of the foreign model. Messrs. Zentmayer, Bausch & Lomb, Queen, Bulloch, the Gundlach Optical Co., and other American makers, not only deserve the highest credit for what they have accomplished and are doing, but they are meeting with the gratifying and universal success which they have been earning.

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Questions.—It would doubtless add to the value of the JOURNAL if any who may have questions they desire to ask about microscopical or biological matters would forward them. We are always glad to receive questions from

any of our readers, and take pleasure in answering them so far as possible. Let all our friends, even the beginners, feel free to make inquiries. When you think the JOURNAL is not popular enough in tone ask some popular questions. If you want it more technical ask such questions. Let us know your needs from time to time.

——o——

Hydrophobia.—This disease and its cure by Pasteur's method must interest every biological reader by its merits and every student of psychology by the various attitudes of mind with regard to it. Those who attach great weight to authority accept at once the previous work of Pasteur as a sufficient guarantee in the present instance of his having reached valid methods for the treatment of hydrophobia. Others more skeptically inclined find the difficulties too great, and are the extremists of unbelief. If one may judge from the editorial remarks of various journalists, there are but two courses—consent to Pasteur's method and its entire rejection. Those who accept the former position and strongly argue it received a very strong accession of support when the English Commission, which investigated the method of M. Pasteur, returned its favorable report. And that decision should, very properly, have great weight in the judgment we form of the merits of the question. But while the affirmative is thus being strengthened the negative receives apparently strong support from certain failures to cure the disease. And the argument of facts seems to contradict M. Pasteur. Then the negative asserts that Pasteur's so-called cures were not genuine cases, and that the patients would not have died even had no treatment been adopted. Here the negative has a strong position, for it is obviously less easy to show that a man would have died had the cure not been attempted than to prove that he has died in spite of treatment by Pasteur. And yet in this latter case the proof is not as clear as it appears, for the question is not did the man die after a cure was attempted, but in any particular case did the experimenter have a fair chance; did his medicine really combat the trouble under possible conditions and fail to cure it? The argument is brought forward by a writer in a recent medical journal that the cure is not able to operate in the case of hydrophobia, because in the inoculation method for small-pox the inoculation must precede the exposure to disease, while here the inoculation is practised after the exposure. This argument only places the Pasteur inoculation among cures and takes them out of the list of preventives; it does not argue against its efficacy.

The cry against Pasteur is very much out of place in a scientific periodical. To the unlearned every act of a skilled performer, whether it be with the microscope, the test-tube, or even the printing press, has an element of wonder which is psychologically much the same as the reference of unknown things to magical powers or to the supernatural. M. Pasteur may not win our entire consent to his system, and there may be numerous cases of real or apparent failure among the cures he has attempted, but we shall not, therefore, denounce him and his studies. Is he not an honest seeker after truth, and shall we, because his line of search is novel, refuse him credit? Science is not furthered by attacking those whose talents and studies fit them for investigations beyond the customary range. The follies of life do not deserve the money we spend in their celebration if we deny to investigators the funds to prosecute expensive but important researches. Both the successes and failures of M. Pasteur deserve fair consideration, and a suspension of judgment, so far as concerns the final acceptance of the method, until it has been sufficiently tested. His past history, as well as the numerous apparent successes he has had, justify this recommendation.

NOTES.

Remittances by mail.—The arrival of many letters containing dollar bills and postal notes reminds our publisher to say that the safety with which the United States mails carry such letters is marvellous and almost perfect. No word has come from anyone indicating the loss of a single letter by the way. Do your part right and you can trust our mail service quite implicitly. But the following hints should be remembered:—

1. Use much care in addressing your envelope, so that you make no mistake therein. Be sure your own name or address is on the upper corner, so that the letter may, on no account, go to the dead-letter office.

2. If your envelope is more than 5½ to 6 inches long, or than 3 to 3¼ inches wide, or if it is of brittle paper, the strings of the postal clerks may cut or tear it, exposing to view the enclosed money. Therefore, use small envelopes for this purpose.

3. If your writing paper and envelopes are of thin materials, the enclosed money can be seen by holding the latter between the eye and a strong light. Try it yourself and see.

4. If your dollar bill is an old one, it may have an odor perceptible through the envelope. Avoid this by perfumery or by using a new bill.

5. A dollar postal note is of as much use to a thief as a dollar bill, each being payable to bearer. Go to the expense and trouble of getting postal notes only for sums less than one dollar.

6. Post your letter yourself, observing for the second or third time that it is correctly addressed, well sealed and stamped. Note the exact date and hour of the day you posted it, so that, in case of loss, you can report these items to the postmaster. Such facts will go far towards catching thieves.

7. In sending bank bills, request an acknowledgment by return mail, and if it does not come, write again stating the time and circumstances of your mailing the first letter.

8. If you feel any uneasiness about it, post a letter by a separate mail informing your correspondent that you have sent such a letter, stating when and how.

9. If your letter is received shortly before a mailing day of a periodical, its receipt can be indicated by the change of date on your next wrapper, showing time to which payment has been made.

10. As so many subscribers to this JOURNAL find it convenient to send postal notes and dollar bills, notice is hereby given that every such letter will be acknowledged on a postal card by the first return mail. If the postal does not reach you promptly, lose no time in sending word.

11. Checks on New York, Boston, Philadelphia, Washington, and Chicago (which are the only personal checks we can use without discount), drafts and money orders do not need to be acknowledged by return mail, as they cannot be cashed by thieves. Acknowledgment will be made by change of date on your next wrapper.

12. In remitting money orders, checks, or drafts to a periodical, make them payable not to any person by name, but to the periodical. Then any properly qualified representative can collect them, and the regularly authorized person will not be annoyed by finding his money order or draft payable to an absent person. We sometimes receive them payable to Mr. Hitchcock, who is in Japan, sometimes to the editor in Minnesota, and sometimes to the last year's business manager, and all such prove of much inconvenience.

Mr. E. O. Ulrich is perfecting a method of studying the systematic relations of the fossil Bryozoa by means of sections, wherein it is hoped that sufficiently definite characters can be found in the microscopic appearance of the cell to permit from it the specific identification much more accurately than was possible by the mere naked eye observation of the fossil, even where it is a perfect specimen, and a method which will be applicable to the study of worn specimens formerly useless. Prof. James, of Miami University, Ohio, criticises this method, and thinks it is not possible to distinguish the species, or even in many cases the genera, of bryozoa by the microscopic structure of the cell, that being similar through a wide range of specifically different forms.

A new botanical serial from the Clarendon Press, entitled the *Annals of Botany*, and edited by Profs. Balfour, Vines, and Farlow, has recently published its first number. The number contains four original articles on histological subjects, and in addition reviews and record of current literature.

MICROSCOPICAL SOCIETIES.

WASHINGTON, D. C.—E. A. BALLOCH, *Secy.*

November 8, 1887.—The 67th meeting. The paper for the evening was by Professor Burgess, of the Washington High School (see page 13).

Professor Seaman gave an interesting account of a visit to Mr. Francis Wolle, and of his methods of work. He thought his a fine example of scientific work pushed to its highest development without governmental aid.

A pleasant feature of the evening was the presence of Mr. Walmsley, of Philadelphia, who showed and explained a 'star' microscope of Messrs. Beck & Co. The serial number on this microscope was above 15,000, and in the course of his remarks Mr. Walmsley stated that he alone had sold over 5,000 Beck instruments in the United States since his first connection with that firm. The same gentleman also exhibited a number of fine photo-micrographs.

November 22, 1887.—The 68th meeting. The discussion of Professor Burgess's paper was continued from the last meeting.

Professor Seaman said that *Clathrocystis* is very abundant at Babcock Lake, being the most abundant alga in the District. In its beginnings it is like a bunch of grapes, a mass of cells imbedded in jelly; as it grows the jelly and cells separate and the jelly becomes spherical inclosing the cells, gradually becomes ragged, and presents many openings revealing the cells within.

Dr. Taylor gave a description and demonstration of his method of making wax cells. He said that much complaint has been made about wax cells on account of their becoming 'foggy.' This may occur if cells are made from sheet wax, as in its preparation it is passed between rollers which are continually wet and much moisture is absorbed. The best way of making wax cells is to melt common bees-wax over a spirit lamp; add to it five per cent. of resin; after the whole is melted slightly lower the temperature, but not so much as to solidify the mass in any degree. Slides can then be placed on the turn-table and cells ringed in a moment. A cell can be made and varnished in ten minutes. The wax rings may be covered with a mixture of glycerin and solution of gum-arabic, and cover-glass then be put on and pressed down. The solution becomes hard very soon, and the cover-glass is firmly cemented.

Dr. Schaeffer said he had long hoped that a good and cheap cell would be devised which would hold balsam. The ideal cell is a glass slide with a depression in the centre.

Mr. Chapman said he had been using paper cells made by a pair of dividers with one point sharpened. These cells can be cut rapidly, the outer ring being cut first and then the inner. If these cells are soaked in benzole, placed immediately on the slide, and balsam added, the latter will not run. He cements the cell to the slide with balsam, mounts in balsam, and rings with balsam, and so far has had no trouble.

Dr. Seaman and Dr. Schaeffer confirmed the value of paper cells.

Dr. Taylor said wax cells can be built up, coated with shellac or copal, and made to hold balsam. In his opinion paper cells will be absorbent, but doubtless they can be made non-absorbent by soaking them in wax and coating with shellac and copal. He suggested tinfoil as a material for cells.

Professor Seaman then demonstrated the method of observing multiple images of any object as shown in the eye of an insect, according to the plan given in the *Journal of the New York Microscopical Society* last year.

Professor Skinner showed a photograph of a microtome, by Allen, of Providence, R. I., and also Allen's slide for observation of urinary deposits, which is an ordinary slide with a circular groove cut in it. In this the deposits collect.

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SAN FRANCISCO, CAL.—E. J. WICKSON, *Secy.*

December 15, 1887.—A letter was read from Arthur J. Doherty upon his proposed demonstrations of preparing and mounting microscopic objects. The society intends, on his arrival, to hold 6 meetings, each one to be devoted to mounting a certain class of objects.

J. C. Rümbock, of Vienna, sent specimens of diatomaceous earths from Oomaru, New Zealand, and from Szent Peter and Szakel, in Hungary. There were also donations of the same kind from William Irelan, State Mineralogist, one being from near

Pioche, Nev., and the other from a deposit near the Edge Hill Vineyard, in Napa county. Mr. Riedy and Dr. Riehl reported upon a previous donation from Mr. Irelan from Shasta county, that the earth was rich in diatoms, but contained only a few of the commoner forms.

There was a discussion on the subject of admitting microscopical instruments free of duty, whether for societies or for individuals. The wisdom of such a policy was urged, because it would aid the scientific investigator, while the present tariff continually hampers him. The following committee to memorialize Congress was appointed:—Henry C. Hyde, Dr. S. M. Mouser, Dr. J. M. Selfridge.

Dr. Riehl exhibited Peterson's freezing microtome, which was favorably received. Dr. Ferrer spoke upon cell growth. Dr. H. W. Harkness called attention to the statement of the United States Mycologist, that *Peronospora viticola* was not found in this State, and said that he had found it as early as 1872. An account of its occurrence was published by the California Academy of Sciences in June, 1887.

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American Society of Microscopists.

The list of officers for 1888, which was printed on page 208 of last year's JOURNAL, being somewhat faulty, this occasion is taken to publish a corrected list, as follows:—President, Prof. D. S. Kellicott, of Buffalo, N. Y.; 1st Vice-President, Prof. T. B. Stowell, of Cortlandt, N. Y.; 2d Vice-President, Dr. H. T. Detmers, of Columbus, Ohio; Secretary, Prof. T. J. Burrill, of Champaign, Ill.; Treasurer, Dr. S. M. Mosgrove, of Urbana, Ohio; Executive Committee, C. C. Mellor, of Pittsburgh, Pa; Dr. H. D. Kendall, of Grand Rapids, Mich.; Dr. R. J. Nunn, of Savannah, Ga.

NOTICES OF BOOKS.

Fresh-water Sponges:—A Monograph. By Edward Potts. Philadelphia, Penn. Academy of Natural Sciences. 1887. pp. 157–279; pls. v, vi, viii, ix, x, xi, xii.

The author of this Monograph has laid American zoologists under obligation by the preparation of an interesting and very extensive study of fresh-water sponges. His purpose appears in the following words from his preface:—'My design has been primarily to describe those genera and species, mostly North American, that have been discovered since the date of Mr. Carter's publication (1881); next to detail the results of a somewhat extended examination into the character and variations in North America of those species that have long been familiarly known in Europe, and thirdly to make it valuable for reference as a monograph by adding brief technical descriptions of all other "good species."

'A further purpose, and one that I hold much at heart, is the desire to revive among scientists and lovers of nature an appreciation of the apparently almost forgotten fact of the existence of sponges in our fresh water; to show them that they are easily found and collected; that they are deeply interesting as living objects of study, microscopic and otherwise; and that by simple processes their typical parts may readily be prepared for classification, and the permanent preservation of their various singular forms.'

We deem it the reviewer's duty to discover the purpose of a writer and to report how far, in his judgment, the writer has succeeded in executing it. In this case the claims of the writer are amply met in every particular. Every reader, by the aid of the numerous synoptic keys and fuller specific descriptions, can identify any sponge he may meet, and will learn many facts of general biologic interest in addition to merely discovering the name of the specimen. The illustrations deserve grateful acknowledgment for their maker, Miss S. G. Foulke, of Philadelphia. We do not know whether a supply of the Monograph for general distribution has been provided by the Academy, or upon what terms they could be obtained, but we think the work deserves to find its way into the hands of all naturalists.

Sixth Annual Report of the United States Geological Survey. By J. W. Powell. Washington, D. C. 1885.

This number of an admirable series contains, in addition to the detailed report of the work done by the various survey parties, five extended papers of very general geologic interest. These are:—1. Mount Taylor and the Zuñi Plateau, by Captain C. E.

Dutton. 2. Preliminary Paper on the Driftless Area of the Upper Mississippi Valley, by T. C. Chamberlain and R. D. Salisbury. 3. Quantitative Determination of Silver by means of the Microscope, by J. S. Curtis. 4. Sea-Coast Swamps of the Eastern United States, by N. S. Shaler. 5. Synopsis of the Flora of the Laramie Group, by L. F. Ward. These papers are all thoroughly illustrated; the last by 34 double-page plates, illustrating about 150 species and many genera. The paper of greatest interest is the second upon the driftless area of 10,000 square miles in Wisconsin and adjoining States. If this area were higher than the level of the surrounding drift-covered area, it would be easily imagined that the area was, during the glacial period, a huge summit above the glacial level. 'Strangely enough the margin of the drift, on almost every hand, lies on a slope *descending* toward the driftless area. The drift-bearing ice was stayed in its course, not by some great topographic barrier it could not overcome, but by some agency that arrested it in its downward career on the slopes toward the unglaciated basin.' The study of this problem is continued by the author through six chapters and 120 quarto pages, in which the general topography and stratigraphy of the region are considered, also preglacial degradation and residuary products, circumjacent glacial phenomena, the loess and terraces, finally, the history and genesis of the area inquired into. The general conclusion, broadly stated, is that the area lies beneath the lee of high lands to the north, which diverted the glacial stream from the driftless area.

A Study of the Histological Characters of the Periosteum and Peridental Membrane. By G. V. Black, M. D., D. D. S. 71 figures. W. T. Keener, Chicago. One volume, octavo, muslin, $3.00.

The *Dental Review* is to be congratulated upon being able to publish in its columns so valuable a work as this. From the character of the descriptive text, as well as from the great value of the figures, it is plainly one of the leading works of reference in this department of histology. The completed series of articles are now published in book form by W. T. Keener, of Chicago. They form a treatise upon the above-mentioned topic, giving precise directions for technical handling for section cutting, and a very careful examination of the complete histological structure.

The illustrations, 71 in number, are deserving of the highest credit for the pains which must have been taken both to prepare the original sections and to execute the drawings.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted, Diatomaceous earth from Mégillanes, Bolivia, South America. Can give in exchange either Diatomaceous earth from New Zealand or cash.
E. MICHALEK,
I. Fleischemarkt, No. 1, Vienna, Austria.

Mounted sections of Fœtal Lung (5 months), sections across entire lobe, $\frac{1}{3000}$ in. thick, beautifully stained, in exchange for first-class pathological slides.
W. C. BORDEN, M. D., U. S. A.,
Fort Douglas, Utah.

Correspondence relative to exchange in microscopical material or prepared mounts.
HENRY L. OSBORN, Hamline, Minn.

Wanted, earths, recent diatoms, and miscellaneous objects for mounting. Only first-class material offered or desired.
MARY A. BOOTH, Longmeadow, Mass.

Fossil Diatomaceous deposits (marine) wanted from Bermuda, Virginia, Maryland, California, etc.
I. ELLIOTT, Ardwyn Villa, Aberystwith, Wales, England.

Notices.—All communications for publication should be addressed to Henry Leslie Osborn, Hamline University, Hamline, Minn.

Subscriptions, and all matters of business, should be addressed to the Manager, Chas. W. Smiley, P. O. Box 630, Washington, D. C.

Subscription price $1.00 PER YEAR *strictly in advance. All subscriptions should end with the December number.* A pink wrapper indicates that the subscription has expired. A date on the wrapper indicates the month to which payment has been made.

Orders for slides advertised by A. J. Doherty in the Journals from January to April, 1887, may be sent through the Business Manager, P. O. Box 630, Washington, D. C.

A few copies of Leidy's Fresh-Water Rhizopods, of North America, can still be had at $5.00 per copy.—P. O. Box 630, Washington, D. C.

Remittances should be made by postal notes, money orders, or by money sent in registered letters. Drafts should be made payable in Washington, New York, Boston, or Philadelphia, to the order of the Manager.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the following prices which are net:—Vol. II (1881) complete, $1.50; Vol. III (1882), out of print; Vol. IV (1883) complete, $1.50; Vol. V (1884) complete, $1.50; Vol. V (1884), Nos. 2–12, $1.00; Vol. VI (1885), $1.50; Vol. VII (1886), $1.00; Vol. VIII (1887), $1.00. As calls for Volume I sometimes occur, those persons having copies to dispose of would do well to inform us, and to state their prices.

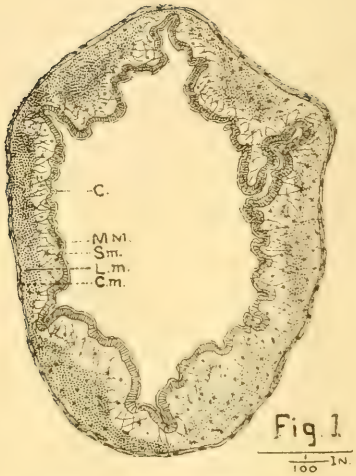

Fig. 1.

1/100 IN.

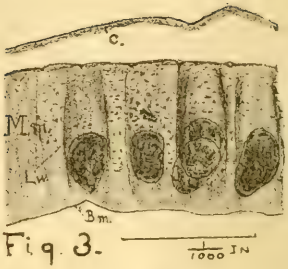

Fig. 3. 1/1000 IN

Fig. 2. 1/1000 IN

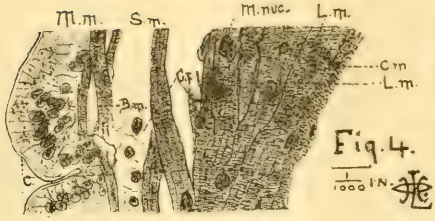

Fig. 4. 1/1000 IN.

INTESTINE OF THE CRAY-FISH.

FIG. 1.—GENERAL VIEW IN CROSS-SECTION. FIGS. 2, 3, 4.—DETAILED SECTIONS.

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Elementary histological studies of the Cray-fish.—VIII.

BY HENRY L. OSBORN.

CHAPTER III.—THE 'INTESTINE.'—(*Continued from Vol. VIII, p. 203.*)

1. **Introductory.**—I may beg the reader's consent to a few prefatory remarks before beginning upon this third chapter of our elementary study in histology. In the first place, for the information of any who may meet this series of articles for the first time, with their perusal of the present part of them, I would say that the purpose of the series is twofold:—to furnish the general reader an exposition of the nature and subject-matter of the study of histology, and second, to prepare a series of articles which may be read by the practical student as a guide and introduction to the study of animal histological observation. In designing and pursuing this course on the elements of histology, I have not thought it necessary to minutely detail a course in microscopical technique which, valuable though it would, perhaps, seem to be in this connection, would divert me from my main purpose. Such a course in technique, moreover, may find a place in these pages at some future time, though it is now very thoroughly and clearly given by a number of writers. How to prepare a slide is the subject of a host of chapters in a host of works. But how to observe, what to see, and what to pass by, what to think about, what is seen, and how to gather up the results of the observations, is a part of the matter usually imperfectly treated or totally omitted in spite of its superior importance. My aim has, therefore, been to study chiefly the slide, and the method only as it is necessary to the study of the slide.

I will add farther and briefly, by way of review, and to show any new readers the ground already gone over in these studies, that I have already considered the structure of the green-gland and the liver of the Cray-fish. Of these the former was found to be a glandular organ, made up of cavities, which were closed in, except at one point of entrance, by a wall made of cells cubical in outline, one layer deep, and seated upon a basement membrane; the cavities of the gland communicating with the interior by means of connected passages opening into one common duct, which in turn opened upon the base of the antenna. This gland further was surrounded by a membranous capsule and so constructed that the blood could circulate upon the walls of the cavities, but in no case pass into the cavities or through them and their communicating ducts to the exterior. The consideration of the green-gland introduces one to an organ of comparative simplicity, and teaches there many of the first lessons which the histologist must master. A study of the liver enforces these lessons by the observation of another organ of comparative

simplicity, though one sufficiently unlike the green-gland to require an entirely new course of procedure. Here again was found a body composed of chambers walled-in in a peculiar manner by a tissue of epithelium cells, forming a mucous lining, opening by ducts which communicate with each other and by a common outlet lead away from the gland. The wall of the cavities, as in the green-gland, was found to shut out the blood from access to the cavities of the chambers, though abundantly bathed with that fluid.

But with these likenesses in plan there was found entire unlikeness in detail, giving rise to entire dissimilarity of actual shape, both of the liver as a whole and of the individual mucous or epithelium cells of its wall. The details of this unlikeness cannot be rehearsed here, but a careful study of them will well repay the student. Both organs, however, are glands; that is, organs of the animal body, whose work is to remove from the blood, or to make from materials removed from the blood, a product which is called their 'secretion.' This product, if of no further use in the body, may be eliminated from the body as in the green-gland; or, if of further use, may be discharged in a desirable locality into some other organ, as the secretion of the liver into the pylorus, to act on the food as it enters the intestine for digestion. I have called these organs very simple ones, because they are composed of only one kind of tissue for work purposes. An organ less simple than these, but still glandular in both structure and use, is the intestine, the organ I shall next consider.

2. **Preparation of the section.** – The location of the organ is not difficult to demonstrate. The central portion of the cephalothorax of the cray-fish is occupied by the large globular stomach, an organ with semi-transparent walls, oval outline tapering posteriorly, and continuous behind into a globular sac, the pylorus, from which passes backward a long narrow tube. The tube, after bending obliquely upward and backward, runs through the entire length of the abdomen, to terminate in an opening upon the underside of the middle plate of the tail fin. This tube is the intestine. It may be removed advantageously at the same time the liver is taken out for hardening, and will furnish very satisfactory sections if treated in the same manner with that organ and the green gland.* I am not prepared to assert that this method is the best or only one which would give satisfactory results, and I am aware it is not the only one, but it is a method which will reveal much, and answers well enough for our present purpose. For the purpose of demonstrating the chief facts in the structure of the intestine, it is necessary to make sections in at least two directions, transverse and longitudinal sections being necessary for the study of the outer coats of the organ.

3. **Gross anatomy.**—The gross structure of the intestine is very easily determined, and has been already, in part, anticipated. To study it properly one should kill a fresh live cray-fish by means of chloroform or ether, and, having carefully removed the carapace and abdominal terga, immerse the specimen in a bath of fifty per cent. alcohol, carefully parting the organs so as to separate them, but without tearing. The specimen, after fifteen minutes, should be transferred to a fresh bath of alcohol, this time of seventy-five per cent.,† and transferred again, after several hours, to alcohol of eighty per cent. or more, if permanent preservation of the anatomical preparation is desired. This examination of the intestine will reveal its relation to the other organs, also somewhat, though but little, of its own construction. It is a nearly straight tube, of small diameter, found imbedded among the numerous muscles of the abdomen, but entirely independent of them; it runs under the poly-

* See vol. viii, page 83; also viii, p. 167.

† In these and all preservations a bulk of fluid equal to at least ten times the bulk of the specimen should be used.

hedral heart and just beneath the dorsal aorta, which runs back from the heart through the abdomen. From this dorsal aorta many very fine vessels may be seen passing to the intestine, provided the gross dissection is very skilfully performed upon a very well-preserved specimen: but the process is made very easy by injecting the dorsal aorta with a colored fluid. The examination of the relation between the intestine and the blood system shows the absence of any venous system or any capillary system, the blood escaping from the fine branches of the dorsal aorta into the body cavity, where it wanders at large, unlike the arrangement in some higher animals. The generative system, also the liver, lie near to or in contact with the intestine anteriorly, but do not communicate directly with it at any point, though the secretion of the liver passing through the pylorus finds its way thence into the intestine. The nervous system of the abdomen lies beneath the intestine and separate from it. It undoubtedly sends frequent nerves to the intestine, but in just what manner these are distributed is not readily demonstrable. The tube itself may be traced from the pylorus, whence it bends upward, running beneath the heart and backward to the anus. The absence of glands opening into the intestine, glands in any way comparable with the malpighian tubules of insects, is an anatomical feature as noticeable as any other to the general student of zoology. The minute anatomy of the tube itself—its three coats, the inner, middle, and outer coats, or muscular, sub-mucous, and mucous coats—is easily demonstrated from specimens thus examined, in addition to the items already mentioned; but this demonstration it is far easier to make upon the sections.

3. **Minute anatomy.**—If we pursue the same method of study which was followed in the last chapter in the examination of the liver, we shall first examine with a low power (50 diameters) a cross-section of the intestine. This process will be the best one to be followed, for it will give the observer a picture of the entire section, a bird's-eye view, showing him how many and various structures will require separate attention. At first the picture will have but very little meaning for the observer, but he will very soon be able to convince himself that the section is really not so complicated and unintelligible as it at first-sight appears. Such a section is represented by figure 1. Examination of the section, with the figure used only as a guide to the section and not as itself the ultimate object of study, reveals a very few different objects, but these repeated a very great many times and repeated in a very systematic manner. If we are able to separate these various elements and learn in what manner they are combined, we shall have gone very far toward unraveling the tangle at first sight presented. And this is exactly what must be done in the case of every section, what is done automatically by the expert observer, and must be learned by the beginner in histological study. In searching for the various elements the observer is met by a difficulty which is, perhaps, more characteristic of studies of living things than of inanimate ones; I mean the wide limits of individual variation among units which all are agreed to call identical in character. This variability is often a source of very great tribulation to the observer, who must learn to see identity in spite of variations, to search for it and to recognize it. If asked, How? the answer is ready, namely, by extensive observation and, thereby, by the discovery of the series of varying forms by which the extremes are connected. If these principles are practically applied to the examination of the cross-section of the intestine, attentive observation will show:—

1. A corrugated band (m. m.), itself, not simple, enclosing a cavity; the line is called *the mucous membrane.*

2. A second band continuous (c. m.) and not corrugated, which runs around the entire section on what seems to be its outer, but is in reality its inner, side; this is the *circular muscle layer.*

3. Between the mucous membrane and the circular muscle layer, and not the latter (l. m.), a portion deeply stained; it is the *longitudinal muscle layer.*

4. Next the mucous membrane (s. m.) a space, which is largely open, but sparingly occupied with branching pieces of stained material; these are the supporting or connective tissue portion of the organ called the *sub-mucous layer.*

5. In addition to the parts mentioned and not shown in figure 1, though distinguishable on the section close to the mucous membrane, scattered through the sub-mucous layer, are muscles which move the mucous layer—*the muscles of the mucous membrane.*

In addition to the cross-section figured in 1, it is necessary to examine longitudinal sections passing through the centre of the intestine called 'radical sections,' and compare them with the transversal sections, identifying in the latter all of the 5 parts already discovered by an examination of the transverse section. Such a section is represented in both figure 2 and figure 4, though on a very much larger scale than that employed in figure 1. When the results of these two examinations are put together, the combined result will be somewhat as follows:—

1. **Mucous membrane.**—The lining next to the cavity of the intestine is a continuous, unbroken sheet, which is to be found in all sections longitudinal or transverse next the cavity. It is not a smooth lining, but is everywhere thrown in folds which, further, do not all of them run in any definite direction, but are extreme, irregular in both depth and direction. This fact is shown by the sections in any of which such huge corrugations, as are shown in figure 2, may be noticed. It is seen, in addition, that the mucous lining does not follow the contour of the circular muscle layer, except in a very rough way, its bendings and foldings being entirely independent of the outline of the circular muscle layer. The extent and arrangement of this membrane being thus determined, we may inspect it somewhat more closely, discovering a number of different component parts which, together, form the broad band. This band is recognized by its color, and the disposition in it of deeply colored red nuclei, and traces of the elements, *the cells*, of the mucous membrane. The examination will show further (*c*) a transparent, very thin layer upon the outer ends of the cells which compose the mucous membrane, *the cuticle.*

2. **The circular muscle layer** is seen from the longitudinal and transverse sections to be a very thin coat which binds together all the remaining parts of the intestine. It is a coat of rather even thickness, and, even with a low power, its histological structure can, though with difficulty, be seen. It is found present through the entire length of the intestine, in longitudinal sections, as in figure 4, at c. m.; it is cut across and presents an appearance very unlike that of the cross-sections of the intestine.

3. **The longitudinal muscle layer** appears very differently in cross and longitudinal sections, but, of course, is found in the same situation in each, namely, next the circular layers and adhering closely to it. It is seen to be very much greater in extent, reaching across one-half the thickness of the intestine wall, and the radial sections show why the layer is called *longitudinal* (see fig. 4), its various elements having very distinctly a distribution parallel with the long axis of the intestine. The fine histological structure of these parts will claim attention presently, but for the present let me merely call attention to the general anatomical feature, the relation of the various component parts of this complex organ—the intestine. The longitudinal muscular layer is not definitely bounded by an even surface upon the side toward the mucous membrane, but is in places apparently 'frayed out' by bands which stretch from it into the sub-mucous coat, as may be seen in both the

long and the cross-sections; this is shown in figure 1, by the irregular contour of the deeply-shaded portion which correctly represents the distribution of this layer. The longitudinal muscle is vastly greater in extent than the circular, and is in its fine structure seen to be vastly more important.

4. **The sub-mucous layer** may be considered as a space filled with packing tissue and binding the mucous coat, one working part of the organ to the muscular coat, the other working part of the organ. This coat, as it is often called, scarcely deserves such a name, for it is hardly a coat or layer in the sense of the word as used of the two real coats, the muscular and the mucous. It is difficult to fully demonstrate its real character, but its general anatomical relation may be readily understood from the sections as shown in figures *1*, *2*, *and 4*. It comes between the mucous lining and the muscles, allows the foldings of the former to exist independently of the contour of the latter, and furnishes a space where blood may wander at large for purposes to be referred to when we have studied a little more closely into the histology of these layers.

5. **The muscles of the mucous lining** (fig. 2, M. muc.) require notice at this point as they may be everywhere observed in close relation with the mucous layer. They are also often closely connected with the longitudinal coat, and it would be a likely question whether they were not a part of it. They do not run longitudinally always and are disposed in a number of ways at angles with one another, as they are but a small layer as compared with the two other muscular coats and would be easily overlooked.

Summary of minute anatomy.—After this survey of the sections with low power to find out the various parts of the organ and combine them, we may sum up the facts of the minute anatomy of the intestine in this wise:—The long narrow tube which the intestine appears to the naked eye when taken from its natural position is found upon examination, while much simpler in its general shape and arrangement than is the liver or green-gland, to be really much more complex in regard to the variety of different tissue used in its construction. It is a hollow tube with a wall of varying thickness, this wall being composed of a number of different layers all built together in a certain way, first, or next the opening of the tube, a mucous layer, then a fine muscle layer, then an open loose packing, then two muscle layers, one longitudinal and larger, the other circular, enveloping the entire tube. The manner in which each one of the layers is built will next be considered.

Remittances.—The manager has been so pleased with the large number of payments made by subscribers during January and February that this method is resorted to of expressing thanks in addition to the postal acknowledgment sent to each. Please notice the date on your wrapper and see if it agrees with the payments you have made. One of our California friends sent his letter down across the continent *unsealed*, and on reading, 'enclosed please find one dollar,' which we could not find, matters looked dubious; but the next day came a second letter saying he forgot to enclose it. Not a single loss has occurred so far as known. An extremely small number of subscribers have sent registered letters, or even money orders. Nearly all have sent dollar bills carefully folded into their letters. The apparent safety of this mode almost leads us to say it may be done at our risk. If sure the directions given in January would always be observed we would try it. Those who have not yet remitted are invited to make the experiment. They should look for our postal acknowledgment by return mail. If those who have already paid desire the benefit of our club rates at any time during the year, it will be a pleasure to accommodate them. It is not necessary to pay for the different publications at the same time.

Notices of new methods.—I.

By GEORGE C. FREEBORN, M. D.,
INSTRUCTOR IN NORMAL HISTOLOGY, COLLEGE OF PHYSICIANS AND SURGEONS, NEW YORK.

1. STAINING OF ELASTIC FIBRES.

Lustgarten, S.*—Victoria blue, a new stain for elastic fibres and for nuclei.

The author uses victoria blue, a basic aniline dye, made by the Baden Soda and Aniline Manufacturing Co. The fresh tissues are hardened in Flemming's fluid for 24 to 48 hours, then further hardened in alcohol. Sections are stained in a mixture of 1 to 2 parts of a concentrated alcoholic solution of the dye, and 4 parts of water, for 24 hours; then washed quickly (5 to 10 seconds) in alcohol, drained, cleared in oil of bergamot and mounted in balsam.

Connective tissue and cells stain faint green, nuclei a darker green, elastic fibres a light green, but they stand out sharply.

Herxheimer, Karl.†—A new staining method for the elastic fibres of the skin.

Good pictures are obtained with tissues hardened in picric acid, alcohol, and Flemming's fluid; the best results are obtained with tissues hardened in Müller's fluid. The sections should not be over 0.02 mm. thick, and are stained in a mixture of 1 c.c. of hæmatoxylin tincture (obtained from Dr. Grübler in Leipzig),‡ 20 c.c. of alcohol, 20 c.c. of water, and 1 c.c. of a saturated solution, in water, of lithium carbonate. Alum solutions of hæmatoxylin may be employed; good pictures have been obtained with Heidenhein's ½% and with Weigert's solution, but, as a rule, the best results are obtained with the above alcoholic solution. After the sections have remained in the staining fluid for from 3 to 5 minutes they are removed and placed in a dish of the officinal solution of the chloride of iron for 5 to 20 seconds. In this solution an iron lake is formed with the hæmatoxylin, and immediately the decolorization takes place. After removing from the iron solution, the sections are well washed in water, clouds of color being given off, then dehydrated in alcohol, cleared in oil of cloves, and mounted in balsam. The alcohol and water used for dehydrating and washing must be frequently renewed as they soon become acid.

The elastic fibres stain a blue-black and stand out sharply upon the underlaying connective tissue, which is stained a more or less light gray, often shading off into a bluish tint. Nuclei sometimes stain black.

Martinotti, G.§—A simple method of staining elastic fibres.

The tissues are hardened in a 0.2% solution of chromic acid. Sections are well washed in water and stained for 48 hours in the following mixture:—Safranin, 5 gms.; alcohol, 100 c.c.; allow this to stand for several days, and then add 200 c.c. of water. The sections, after being removed from the stain, are washed in water, dehydrated in alcohol, cleared in oil of cloves, and mounted in balsam.

The elastic fibres stain deep black; nuclei deep red; the rest of the tissues diffusely red.

2. SUBSTITUTES FOR HÆMATOXYLIN.

Paneth, Jos.‖—On the employment of the extract of logwood, in place of pure hæmatoxylin.

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* Weiner med. Jahrbucher, 1886, p. 285.
† Fortschr. d. Med. Bd. iv, 1886, p. 785
‡ This tincture is a concentrated alcoholic solution of hæmatoxylin.
§ Zeitsch. f. Wiss. Mikros., Bd. iv, 1886, p. 31.
‖ Zeitsch. f. Wiss. Mikros., Bd. iv, 1887, p. 213.

The author recommends the extract of logwood, which can be obtained from any druggist, in place of hæmatoxylin crystals, for making Weigert's staining fluid for the central nervous system. He makes a solution of 1 part of the extract of logwood in a mixture of 90 parts of water and 10 parts of alcohol; filters and adds to the filtrate 8 drops of a saturated solution, in water, of lithium carbonate. Sections of tissues that have been treated as described by Weigert are placed in this fluid for 18 to 24 hours at the room temperature. They are then decolorized in the borax-potassium ferricyanide solution and mounted in the usual way.

Francotte, P.*—A. 5 gms. of the extract of logwood are macerated in 90% alcohol; 1 gm. of alum is dissolved in 200 c.c. of distilled water. For staining add to a small dish full of the alum solution the alcoholic solution of logwood, drop by drop, until a blue violet color is obtained; filter.

B. Boil 15 gms. of logwood chips in 1,000 c.c. of water for several hours. Then strain through linen, and afterwards filter through paper. Evaporate the filtrate to dryness; dissolve the residue in 50 c.c. of 90% alcohol; allow it to stand for several days and, finally, filter. For staining add this fluid, drop by drop, to a 1 to 300 solution of alum in water, until a blue violet color is obtained.

3. MOUNTING.

Weigert, C.—Preservation of sections without the application of cover-glasses.†

By employing the carbolic acid-xylol mixture‡ for clearing, the use of a cover-glass in mounting can be done away with. The sections, after being placed on a slide, are dried with filter paper, after the manner one would use a blotter for ink. A layer of photographic negative varnish is then flowed over the section and allowed to dry. This takes place quickly, but may be hastened by gently heating the slide. This latter procedure must always be employed when the sections become cloudy, due to the absorption of moisture. After the first layer of varnish has become dry, a second layer is flowed on, allowed to dry, and so on until after drying the sections become glazed.

REPORTS OF RECENT ARTICLES.

Origin of the excretory system of the earthworm.—Prof. E. B. Wilson§ has called attention to the remarkable similarity between the development of the nephridia and the origin of the excretory system in vertebrates. Germ bands arise as in Clepsine ending behind in 8 large cells, by whose continued division the bands increase in length; of these, two are mesoblasts (giving rise to the dissepiments, muscles and vessels), two are neuroblasts (giving rise to the excretory organs), the fate of the remaining two being uncertain. The rows produced from the nephroblasts and the nephridial rows produce in each somite a pair of solid outgrowths from which the nephridium is eventually formed. Thus the nephridia arise as metameric growth from a solid cord of cells, and is thus essentially similar to mode of origin of the vertebrate, head kidney or pronephros.

The nephroblast, when traced back to its origin, is demonstrated to be on an ectoblastic cell only later, larger than the rest, and imbedded in them, and

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*Manuel de Technique Microscopique, 1887, p. 221.
†Zeitsch. f. Wiss. Mikros. Bd. iv, 1887, p. 209.
‡Xylol 3 parts, acid carbolic 1 part. All water must be removed from this mixture by adding an excess of anhydrous cupric sulphate, prepared by heating the powdered crystals at a temperature of 100 C. until a white powder is obtained (*Weigert, Zeitsch f. Wiss. Mikros. Bd. iii, 1886, p. 480*).
§Proc. Acad. Nat. Sci. 1887, p. 49.

the nephridia are therefore unquestionably ectoblastic structures. Prof. Wilson believes this to establish two interesting homologies :—1, that between the nephridial row of humbricus and the Wolffian duct of vertebrates ; and, 2, that between the annelid nephridium and the vertebrate head-kidney or pronephros.

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Tumor of the oyster.—Prof. John A. Ryder* examined an oyster into whose pericardiac cavity a large tumor had grown. This growth measured an inch in length and one-half that in thickness, the animal being about three inches long. The tumor was soft and yielding ; consisted of eighteen distinct lobes of irregular size fastened to the tissue which surrounds the rectum. The histological examination of the tumor showed it traversed by vessels and made up of connective tissue somewhat similar to molluscan connective tissue ; large, thin-walled cells with a complex central mass of protoplasm suspended by a radiating network fastened to the wall. The tumor was of interest as showing that lower animals are not exempt from morbid growths.

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Notes on the Umbelliferæ of the United States.—J. M. Coulter and J. N. Rose† have presented a scheme for the identification of the species of Umbelliferæ by means of the study of sections of the fruit and its surface characters. The ribs of the carpels, whether connected by reticulations or not, whether developed into wings or corky ridges or not, the outline of seed, nature of pericarp and sub-section, size and situation of all ducts, varying numbers are found to be among the most valuable diagnostic characters. The series of papers, which, in December, had reached number viii, will, when complete, have discussed every species east of the 100th meridian and illustrated all by at least a transverse section of the carpel.

The staining of animal and vegetable tissues.‡—II.

By ARTHUR J. DOHERTY.
MANCHESTER, ENGLAND.

(*Continued from page* 12).

KLEINENBERG'S ALCOHOLIC HÆMATOXYLIN.

§ ' Prepare a saturated solution of calcium chloride in 70% alcohol, with the addition of a little alum ; after having filtered mix one volume of this with from six to eight volumes of 70% alcohol. At the time of using the liquid pour into it as many drops of a concentrated solution of hæmatoxylin in absolute alcohol as are sufficient to give the required color to the preparation, of greater or less intensity, according to desire.'

Place the piece of tissue in this solution for from six to eighteen hours, or until the stain has penetrated to the very centre ; then transfer it to 90% alcohol, which must be changed time after time until it is no longer colored by the hæmatoxylin. The tissue may then be infiltrated with parafin wax and spermaceti mixture, cut into sections, and mounted in the usual manner.

The method is also applicable to the preparations of many soft or spongy vegetable tissues, *e. g.*, stellate parenchyma, the tissue being afterwards im-

*Proc. Acad. Nat. Sci , Philada., 1887, p. 25.
† Bot. Gazette, 1887, January, etc.
‡ Reprinted from Transactions of Manchester Microscopical Society, 1886.
§ The ' Microtomist's Vade-Mecum.'

bedded in soap mixture (*i. e.*, soap dissolved in alcohol and mixed with glycerin).

The following formulæ for the preparation of logwood stains are given in Dr. Sterling's 'Text-book of Practical Histology' (London: Smith, Elder & Co.) :—

1st. A. Dissolve .3 grns. of hæmatoxylin in 10 cc. of absolute alcohol. B. Dissolve .3 grns. of alum in 100 cc. water. A few drops of A added to a few cc of B. give a solution of a beautiful violet color, which rapidly stains tissues.

2d. Take 60 grns. of extract of hæmatoxylin and 180 grns. of alum; rub them together in a mortar, and slowly add 280 cc. distilled water. Filter, and to the filtrate add 20 cc. of absolute alcohol.

LOGWOOD SOLUTION FOR RAPID STAINING.

This solution, devised by E. A. Cook, yields good results, but it has no advantages over any of the above. The ingredients are extract of logwood and alum, of each 6 parts, cupric sulphate 1 part, and water 40 parts. Grind in a mortar the alum, logwood, and cupric sulphate, all of which must be iron free, and when powdered add sufficient water to form a thin paste. Leave this for one or two days, then add the remainder of the water, and filter. To the filtrate add a crystal of thymol, to preserve it from mould. For tissues hardened in chromic acid add 8 drops of this solution to 120 drops of water, and add one drop of a tenth per cent. solution of potassic bichromate just prior to use.

DR. BEALE'S CARMINE FLUID FOR STAINING GERMINAL MATTER.

Next to logwood stains may be placed the different preparations of carmine. These were much used by the older microscopists, and are still extensively employed on the Continent; though in many cases they have been given up in preference for logwood and anilin stains, which are not so trying to the eyes.

Carmine, 10 grains.
Strong liquor ammonia, ½ drachm.
Price's glycerin, 2 ounces.
Distilled water, 2 ounces.
Alcohol, ½ ounce.

The carmine is to be dissolved in the ammonia with the aid of heat and the glycerin, water, and alcohol added after.

Dr. Beale says:—'The rapidity with which the coloring of a tissue immersed in this fluid takes place depends partly upon the character of the tissue and partly upon the excess of ammonia present in the solution. If the solution be very alkaline, the coloring will be too intense, and much of the soft *tissue*, or imperfectly developed formed material around the germinal matter, is destroyed by the action of the alkali. If, on the other hand, the reaction of the solution be neutral, the uniform staining of tissue and germinal matter may result, and the appearances from which so much may be learnt are not always produced. When the vessels are injected with Prussian blue fluid, the carmine fluid requires to be sufficiently alkaline to neutralize the free acid present. The permeating power of the solution is easily increased by the addition of a little more water and alcohol. In some cases the fluid must be diluted with water, alcohol, or glycerin; and the observer must not hastily condemn the process, or conclude, as some have, that a particular form of germinal matter is not to be colored, until they have given the plan a fair trial and tried a few experiments.'

I have found the following preparation of carmine to be very useful for staining both germinal matter and formed material of animal sections :—

1 grain carmine,
25 cc. water,
3 cc. ammonia.

Dissolve the carmine in the ammonia ; then add the water ; filter and preserve in a stoppered bottle.

' Thiersch's carmine fluid.*—Frey (*Das Mikroskop*) gives Thiersch's fluid for coloring tissue by carmine :—

Carmine, 1 part ;
Caustic ammonia, 1 part ;
Distilled water, 3 parts.

This solution is to be filtered.

Oxalic acid, 1 part ;
Distilled water, 22 parts.

One part of the carmine solution is to be mixed with eight parts of the oxalic acid solution, and 12 parts absolute alcohol are to be added.

If the solution is orange colored, instead of dark red, more ammonia is required, and the orange becomes red. The orange color may also be used for staining. If crystals of oxalate of ammonia become formed, they must be separated by filtration.'

GRENACHER'S ALCOHOL BORAX CARMINE.

This is useful for staining preparations of Hydroid Zoophytes, Sponges, Annelids, Crustacea, and also for coloring many animal tissues *en masse*. Make a four per cent. solution of borax in water, and add an equal quantity of a two and a half per cent. solution of carmine in water. Allow the mixture to stand for three days, and then add an equal bulk of 70% alcohol. The liquid must now be allowed to stand again for about a week, when the dark red supernatant portion should be syphoned off from the lower light-colored stratum of precipitated carmine.

Sections stain in this fluid in a few minutes ; they should be washed in about 60%, dehydrated in 90% alcohol, cleared in clover oil, and mounted in Canada balsam.

CARMINE FOR VEGETABLE TISSUES.

1½ grms. carmine,
5 cc. ammonia,
95 cc. water.

Dissolve the carmine in ammonia, add the water, filter the mixture, and preserve it in a stoppered bottle. This preparation is useful either in single or double staining. The sections require to be bleached and mordanted. If it is desired to preserve the nuclei, protoplasm, or other cell-contents, the sections must be bleached by placing them in 90% alcohol, and keeping them in it until every trace of chlorophyl has been abstracted. They are then placed in water for ten minutes, after which they are transferred to a 2% solution of alum in water for twenty-four hours. The action of this mordant is to precipitate the carmine in the tissues of the section in so finely divided a form that the granules are invisible even under the highest powers of the microscope. In investigations on the shape or peculiarities of cell-walls, or the crystalline contents of cells, the following bleaching agent may be used with advantage :—Rub up in a mortar two ounces of fresh chloride of lime with two ounces of water, and make up the mixture to one pint ; allow it to

* ' How to Work with the Microscope,' p. 110.

stand for a short time, and, when the lime has partially settled, add a sufficient quantity of a saturated solution of common washing soda to cause the mixture to become thick and turbid. It is allowed to stand for several days, and the clear supernatant liquid is then syphoned off and preserved in a stoppered bottle, which should be kept in a dark place. This fluid bleaches rapidly, usually in from 15 to 30 minutes; and care should be taken not to submit sections to too prolonged action, as, being to a certain extent a solvent of cellulose, the sections would be disintegrated and destroyed.

MAYER'S COCHINEAL TINCTURE.

Cochineal, 1 gramme,
Alcohol (70%) 10 cc.

Rub up the cochineal in a mortar and mix it with the alcohol; in five days the clear fluid is poured off, and is filtered before being used. This stain, which in its action is similar to Kleinenberg's hæmatoxylin, is useful where a higher degree of penetration is required than that possessed by the ordinary aqueous solutions of carmine or cochineal. I have found it very useful for brain and spinal cord, and for scirrhus and carcinoma of the breast.

KLEIN'S COCHINEAL FLUID.*

'One per cent. of alum and cochineal in distilled water are boiled to four-sevenths of the original volume; when cool, a few drops of carbolic acid are added, and the liquid filtered. Sections will stain well in three or four hours, but will not be injured if left twenty-four hours. They require nothing but washing in distilled water. The branching process of Purkinge's cells in the cerebellum, the connection of the kite-shaped cells of the cerebral cortex, and the "chief" and "investing" cells of the gastric mucous membrane are rendered especially evident by this method.'

NEW METHODS OF PREPARING CARMINE STAINING FLUIDS.†

'Sig. G. Arcangeli states that the unsatisfactory results, and the instability of the ordinary carmine stains, induced him to try other methods, and he has obtained excellent results by the following modifications:—

'1. Boil together 100 grammes distilled water, 4 grammes boric acid, and 50 centigrammes carmine for about 10 minutes; filter when tepid. The fluid gives a beautiful cochineal-red stain, much resembling that of eosin. The nuclei of vegetable tissues attain their maximum of coloration in about twenty-four hours. The cutaneous epithelium and muscular fibres of *Rana esculenta* stain well. It is necessary to be aware that the sections should not be washed more than twice or three times in water, and should then be transferred to alcohol, which seems to set the stain.‡

'2. Another carmine stain, which gave the best results, was obtained by boiling for about 10 minutes 100 cc. of a saturated solution of alum, 2 grammes of boric acid, and 25 centigrammes of carmine. The fluid so obtained is of a fine violet-red color, and stains the nuclei of animal and vegetable tissues in about twenty-four hours; and according as the sections are placed in an alcoholic or aqueous solution of the stain, so is the greater or less rapidity of its action. When used in an alcoholic solution, the stain is rapid, and the whole of the cell participates in the process. When in combination with water only, the action is slower and the nucleus alone is affected.

'3. A third stain was made by substituting salicylic for boric acid. 100 grammes of a saturated solution of alum, 25 centigrammes of carmine, and

* Journal of the Royal Microscopical Society, for 1881, p. 957.
† Journal of the Royal Microscopical Society, for 1885, p. 1095.
‡ Alcohol fixes a carmine stain by precipitating the pigment.—A. J. D.

25 centigrammes of salicylic acid are boiled together for ten minutes. The fluid thus obtained is of a redder hue, and its stain a more vivid red than that of the preceding fluid. Vegetable and animal tissues stain in about twenty-four hours.

'4. Satisfactory results were obtained by boiling 25 centigrammes of carmine with 50 cc. saturated solution of boric acid for ten minutes and filtering. The fluid thus obtained much resembles in its action and appearance picro-carmine.'

We now come to the metallic substances, osmic acid, nitrate of silver, and chloride of gold; these are used in the form of weak aqueous solutions, and are very useful in certain kinds of animal histological work.

Osmic acid can be obtained in two forms—pure, in crystals, and as a 1% solution. If obtained in the latter form, it should be diluted with an equal bulk of water; or, if the crystals are purchased, a ½% solution should be made. It is very volatile, and as it is easily decomposed by actinic light, or by being brought into contact with organic substances, it should be kept in a stoppered bottle in a dark place. Osmic acid combines the properties of a hardening, staining, and fixing agent; as a staining agent it acts by bleaching fat cells, for which it has a great affinity. In the study of medullated nerve-fibres, a 1% solution is the most useful strength. It should be allowed to act upon the nerve for fifteen minutes, after which time it will be found to have completely blackened the phosphorized fats of the myeline.

Nitrate of silver is used for staining the intercellular substance of epithelium, cartilage, and the cornea; also for demonstrating 'Ranvier's Crosses' in medullated nerve-fibres. Tissues to be stained with silver nitrate solution must be perfectly fresh, and should invariably be first rinsed in distilled water to remove soluble chlorides. They are then placed in a ½% solution until they assume a milky appearance, after which they are removed into ordinary water, washed, and mounted in glycerin or Canada balsam. The mounted preparations are exposed to a strong light until they turn brown, and always afterwards, when not in use, they should be kept in a dark place. In cases where the solution has been used for showing the existence of epithelium, an examination under the microscope will show that the silver has been precipitated in the intercellular substance; but in medullated nerve-fibres, the silver lines will be found transversely on the cement uniting the nerve-segments, and longitudinally on the axis-cylinder for a short distance on each side of the transverse bar.

Chloride of gold is a most useful reagent for staining cartilage, tendon, developing capillaries, nerve-plexuses, and nerve-ganglia. As in staining with silver-nitrate solution, the tissue must be perfectly fresh, and must be washed in distilled water; it is then transferred to a 1% solution of the salt for half an hour, washed, and placed in water acidulated with acetic acid, 3 drops of acid being added to every ounce of water. In twenty-four hours the gold will be completely reduced, and the tissue, which will be of a deep violet-color, is then washed and mounted.

If a tissue is thick or dense and covered with epithelium, the method of staining with gold chloride solution is not altogether satisfactory; in such cases the following process yields much better results. Wash the fresh tissue in distilled water, place it in filtered lemon juice for five minutes, wash it again in water, and transfer it for half an hour to a 1% solution of gold chloride; the tissue is again washed, and is then transferred to a mixture of three parts of water, and one part of formic acid. Treatment with this for twenty-four hours reduces the gold and removes the epithelium, so rendering the underlying parts more transparent and suitable for examination. The tail of a half-grown tadpole treated in this way makes a very fine preparation for the mi-

croscope; the blood corpuscles are seen *in situ;* a large artery winds its sinuous way across the field, and gives off branches which, gradually becoming smaller and smaller, dwindle away into capillaries; these in turn gradually increase in size, and unite with branches of a large vein, which returns the blood to the heart. These structures, stained a rich and beautiful violet, stand out with the most wonderful distinctness, and make up a picture which, once seen, is not soon forgotten.

(To be continued.)

Notes from Japan.—V.

By ROMYN HITCHCOCK,
OSAKA, JAPAN.

OLEOMARGARINE.

In looking over Bulletin No. 13, of the Department of Agriculture, which is mainly devoted to the adulteration of foods, and, particularly, of dairy products, one cannot but be impressed with the unanimity with which chemists assert the entire wholesomeness of oleomargarine, when properly prepared, as an article of food. Prof. C. F. Chandler even goes so far as to declare that it really is butter; and its chemical composition is such that one can scarcely believe there is the slightest difference in physiological action between this and natural butter. Yet, everyone knows of the recent legislation, in the interest of dairymen, evidently intended to prevent the manufacture of this cheap and useful article of food.

The reason for alluding to this subject is to point out the unfounded character of the attacks upon oleomargarine or other butter substitutes prepared from pure animal fat, and to advocate the use of such substitutes especially among those who are obliged to exercise economy in living. Any legislation to tax this article is a direct tax upon the poor man's table; for not only does it raise the price of cheap and healthful articles of food, but it also enables the producer of natural butter to sell at a higher price than the natural course of competition in trade would allow. Such legislation—all legislation that interferes with the normal course of trade—is to be deplored, but especially so when it increases the price of one article of food to benefit the producers of another. A short time ago one might almost have believed that the oleo industry threatened the extermination of the whole dairy business of the country! But the newspapers are not always reliable indicators.

Now, as to the use of artificial butter, I would say that it is certainly far better in flavor than some of the pure butter we have in Japan, sold in cans at 50 or 60 cents per pound. Yet, so great is the prejudice against oleomargarine, that it is doubtful if it could be introduced here, even for kitchen use. At home, how many of the poorer classes use it? With them it requires a long time to overcome old notions. It will be found on inquiry, no doubt, that they still prefer the cheap and inferior natural butter to the far more palatable product.

Nevertheless, the sale should be controlled so that adulterations may be punished. It should not be taxed, but it should be sold on its merits. It is cheap, and butter is dear.

Dr. Wiley has published a very useful bulletin for those who wish to examine dairy products, and the processes used in the laboratory of the Department are given. Considerable differences of opinion are expressed concerning Dr. Taylor's microscopical tests of butter, but, on the whole, the verdict seems to be in his favor.

The public mind catches up a deal of science now and then, but it is not always very sound. Perhaps there is no doctrine more generally accepted among well-informed people than that of the germ origin of disease, and there is nothing that is dreaded more in city houses than 'sewer gas,' which is supposed to carry all sorts of germs right into the house. Now, while not advocating the general admission of sewer gas into dwellings as a sanitary measure, it does not appear to be quite so pestilential as is generally supposed. Indeed, the number of germs actually found in sewer gas is far smaller than might be expected, and, indeed, it would seem that the conditions prevailing in the sewers are almost inimical to the rapid development of germs. At all events the air of sewers is probably harmful more because it vitiates the air, and in this way lowers the general tone of the human organism, thus rendering it more easily attacked by disease, than because of the few specific poisons it may carry.

The microscope in the study of bacteriology.*

By Dr. THEOBALD SMITH,
BUREAU OF ANIMAL INDUSTRY.

A magnification of from 500 to 800 diameters is the most useful in the study of pathogenic forms. The use of illuminators with special reference to that designed by Abbe and now universally employed in bacteriological work was described. Unstained specimens are examined with a small diaphragm to bring out the structural details. Stained specimens are best examined without a diaphragm. The whole pencil of light is thus utilized. The removal of the diaphragm obliterates the structure-picture and substitutes the color-picture. The interpretation of the appearance presented by the same object, a spore-bearing bacillus, stained and unstained, under the two conditions, was given in illustration. The advantage of wide-angled lenses in the searching of sections of tissues for bacteria was dwelt upon. The very thin layer of tissue brought into focus at the same time, even in thick sections, eliminates many disturbing elements.

A description was given of the devices employed in studying bacteria in liquids—and the various cells which are used. The usual way is to examine minute drops of liquid suspended from the under side of a cover glass which rests over a cell in the slide. The great advantages of the so-called stained cover glass preparations in quickly determining the relative number and kind of bacteria in tissues were mentioned, and the method of preparing described. Special culture cells, such as those of Brefeld, Prazmowski and others are used to elucidate problems of a certain character in the biology of micro-organisms.

In endeavoring to fulfil the three conditions laid down by Koch, necessary to the complete demonstration of the etiology of infectious diseases, the microscopical examination of tissues for the presence of bacteria comes in first. Histological methods are also of great service in determining the action of bacteria on tissue elements. They inform us whether bacteria are intracellular or not, and what the nature of the pathological process is which is caused by their presence. Before the technique of staining came to its present perfection, acetic acid, alkalies, ether, and chloroform were frequently employed. Sections of tissues were immersed in strong acetic acid or dilute caustic potash or soda to dissolve the cell protoplasm and the formed elements. The bacteria remain unchanged and could be easily detected. These methods are crude and rarely used except as accessories to staining methods. The speaker

*Report of a paper read before the Microscopical Society of Washington, D. C., December 13, 1887.

described the kinds of anilines most employed, and the solutions used—watery solutions made from alcoholic solutions are generally useful. In most instances, however, alkalies or aniline oil are added to the solutions to increase the staining power.

It has been customary to overstain tissues and then remove the stain in part with the aid of solvents or destroyers of the staining agent. The most important are acetic acid, iodine, and nitric acid. A detailed account was given of several methods which are of special value, such as the one proposed by Gram and the one which is employed to differentiate tubercle bacilli. The methods for demonstrating and differentiating bacteria are being constantly improved, and a large mass of literature has already accumulated on this subject.

MICROSCOPICAL TECHNIQUE.

The Bastin-Bullock Microscope is the name of a new instrument described in the December number of the *Western Druggist*. It is designed by Professor Bastin especially for the needs of pharmacognosists. The instrument is compact with a hinge joint at the base of the stage, coarse adjustment by tube sliding in a sleeve, screw fine adjustment, all the parts of brass except the iron tripod base. It is furnished for $35 with $\frac{2}{3}$ or $\frac{1}{8}$ inch objective, or $30 with same objectives of American make. This instrument has been designed for use in a course in vegetable histology which the editor of the *Western Druggist* announces to be begun in January.

EDITORIAL.

Practical courses.—Very commonly now-a-days, and as properly, the scientific journals are publishing nice elementary courses of study upon the outline plan introduced by Prof. Huxley and since adopted by numerous text-book writers. We have already referred to some of these courses, and with the new year others are appearing. Prof. E. L. Bastin, the author of a work of unusual merit* upon botany, begins, in the *Western Druggist*, a series upon vegetable histology. These practical and easily-followed studies are upon the vegetable cells of the onion. The first study of the series, we are glad to see, gives a good share of attention to *microscopic* investigation, a subject which is far more important than microscopical technique. Two of the editors of *The Microscope* have also initiated courses of direction for practical study. These are conducted by Dr. Manton and Dr. Brown—the one in 'Embryology' (animal), the other in 'Animal Histology.' We receive frequent queries from those who would gladly use their microscopes for their own interest and the profit of science and who want to know how to go to work. Surely with these three lines of direction before us, and with such books as Dr. Stokes' Microscopy for Beginners, and others, every one can find something to fit his case and to interest him in the modes of work. In our next issue we shall invite beginners to a study of the yeast plant.

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To the American Society of Microscopists.—This and other microscopical societies might very properly be united for action, which would

* See this JOURNAL, vol. viii, p. 139.

be very helpful to their members. Plans should also be formed for the benefit of those who are remote from existing centres. The Agassiz Association, with its general organization and the courses of instruction in mineralogy carried on by mail by Prof. Crosby, of Boston, and others, has suggested a way in which scattered persons desirous of doing work of permanent value may first instruct themselves sufficiently and afterwards enter upon co-operative work.

This would include the formation of classes for instruction by some one competent to examine the work and criticise it. The organization might well be made a department of the *American Society of Microscopists*. By constant communication an interest would be kept up. It is not improbable that such a plan might yield unexpected results. Much work is now done which is not in vain, and yet which is not used. At first only trained observers could contribute results sufficiently trustworthy, but the rest would be in training, and, aside from the pleasure of study, there would be the ever-increasing ability which must make them in time experts. We learn from the *Botanical Gazette* that the botanists are agitating a plan for utilizing the energy now wasted by isolated students. Will not some ingenious organizer show the microscopists how they can combine for work? Will a committee of the American Society of Microscopists prepare a programme of topics for work and circulate it first among the more expert microscopists? If leaders can be found to take the work in hand the societies and isolated individuals combined can contribute a vast amount of information on the life or habits of the micro animals and plants, as well as upon geographical distribution, variation in specific form, etc. Other kinds of studies in histology or embryology might be made productive; for instance, in pathology. For the benefit of physicians one department of morbid histology could be formed. May not great general interest and individual improvement result from such a scheme? Is is utopian to hope therefrom for additions to our knowledge in botany and zoology?

NOTES.

The American Journal of Psychology is the title of a new journal to be published quarterly by Johns Hopkins University. It will be edited by Prof. G. Stanley Hall. From the well-known character of the Psychical Research conducted at Johns Hopkins University, as well as from the table of contents of the first number, it is apparent that we have here not one more to be added to the list of journals of speculative metaphysics, but an organ of psycho-physics. We heartily sympathize with, and endorse, all attempts to improve and spread the new psychology, but are not to be understood as therefore entirely discarding the use of the 'introspective method;' both are well and should be pursued. We trust that the new journal will not ignore the truth of the old psychology, or desist from attempts to find how much in it is truth and not human error.

QUERIES.

Q. Can you recommend me a good instrument to be used in mineralogical studies and general use, and say whether monocular or binocular will do the best work with same power? E. L.

A. The Bausch & Lomb Petrographical miscroscope, designed from the description of Prof. G. H. Williams, of Johns Hopkins University, is recommended for petrographical studies, and it can also be used for general purposes. The Monocular stand is the only one made, and the Model stand is a very good one.—Ed.

MICROSCOPICAL SOCIETIES.

Montreal Microscopical Society.

The annual meeting was held October 10, 1887, and the following officers elected:—President, D. P. Penhallow; Vice-President, J. Stevenson Brown; Secretary and Treasurer, A. Holden.

At the meeting of November 14 the president read a paper on 'The Microscope as an Aid to Research.'

At prior monthly meetings in 1887 the following papers were read:—Rules for Distinguishing Animal from Vegetable Organisms, by Very Rev. Dean Carmichael. Bacteriological Methods, by Dr. J. B. McConnell. Modes of Mounting Objects for the Microscope, by J. Stevenson Brown. Use of the Microscope in the Inspection of Meat, by A. W. Clement. Chalk as seen through the Microscope, by Rev. Dr. Smyth. The Determination and Results of Minute Materials, Physiologically and Microscopically Considered, by Dr. Wanless.

—o—

Washington, D. C.—E. A. Balloch, *Secy.*

December 13, 1887.—69th meeting. Dr. Theobald Smith, of the Bureau of Animal Industry, described the development of the microscopic methods, and some special features in the use of the microscope in the study of bacteriology.

Dr. Smith said, in answer to queries of Drs. Balloch and Reyburn, any person having a knowledge of the microscope, and a fair acquaintance with what has been done in bacteriology, is competent to study it. Of course he will need high-power lenses, and a condenser will be indispensable. The other apparatus required is neither numerous nor costly. The microscope is only one of the methods used in studying bacteria. We must often check and prove our microscopical observations by the use of culture methods. Two bacilli, so much alike that we cannot differentiate them by the microscope, will give entirely different results when submitted to culture tests. If it be desired to mount preparations of bacteria, I have found xylol-balsam the most convenient medium. It does not remove the color from stainings. The analine dyes now furnished seem to be as permanent as could be reasonably expected.

NOTICES OF BOOKS.

Guide to the Student in Botany. By Edward S. Burgess, A. M. Washington, D. C. 1887. Pamph. pp. 44.

The present work is intended for the use of students in the Washington High School. It supplies them with the outlines of their course in botany, furnishes directions for modes of procedure in laboratory work and in original investigation. It is also intended to convey such information regarding the department as will be wanted by parents and others interested. A portion of the matter is entirely new; another portion has been in use for four years in the school as a syllabus of the botanical course. It is now re-written with such adaptations as have been suggested by experience. The aim of the author is twofold, viz:—'To promote habits of close observation,' 'and to secure a knowledge of the life of plants.' The synopsis is a very complete one for the purpose, requiring the pupil to observe the more conspicuous and easily studied facts in the course of anatomy and systematic arrangement of the Phænoganes. There is reading or lectures upon the finer structure and the preparation of brief essays or theses embodying the results of original observation on such topics as these:—1. Runners:—*a*, characters; *b*, variation in same species; in same individual; *c*, trace development. 2. Twining of stems:—*a*, twining only one way; examples; exceptions; *b*, degree of curve—where, when, and how developed; *c*, sweep of tip—when active, what radius, in how many internodes; *d*, effect of irritation; *e*, action on reaching object; *f*, reversing the sweep.

There are forty of these outlines for observation. The only question we can see as to the usefulness of such a very complete guide as Prof. Burgess has presented is the ability of the teacher who has charge. It is pretty safe to say that no teacher dare stir far from the ancient path as trodden by the numerous plant analyses, etc., unless

he has considerable time for his subject, and sufficient training therein himself to venture out where his feet are not constantly in easy reach of the bottom. Of the value of a course such as is outlined by Prof. Burgess there can be no doubt it would have an educational value not in the least inferior to mathematics or the languages, and far more useful, because it would give the young people something in nature to think about, and watch—a gift worth the taking of anyone. It might at first be thought that so full a course in High-School work would cease to interest the young students, but, if conducted with ability, it would not do so, but have a growing interest. On the other hand it would be a dangerous experiment for the teacher with a mere superficial knowledge of botany to attempt. We should like to see the syllabus extended into a somewhat more complete guide, and especially commend the very considerable attention which the physiological side of elementary botanical study has engaged in it.

The Tongue and Gustatory organs of MEPHITIS MEPHITICA. By Fred'k Tuckermann. London. Allard & Son. 1887. pp. 21. 1 pl.

After the customary historical summary the writer gives first an account of the general anatomy of the tongue, followed by a particular description of the histological structure of the circumvallate papillæ; (2) the fungiform papillæ with figures. There is an enumeration of the bibliography of the subject, 58 works being cited, but no general discussion of the subject.

We desire to acknowledge, with thanks, the following, viz:—

1. *The Germ Bands of* LUMBRICUS. By E. B. Wilson. Boston. Ginn & Co. pp. 12. 1 pl. 2. *Hydrachnides des eau douces des Acores.* By Dr. Th. Barrois. Lille, France. 1887. pp. 16. 3. *Catalogue des Hydrachnides recueilles dans le nord de la France, avec des notes critiques et la description d'especes Nouvelle.* Par Th. Barrois et R. Moniez. Lille, France. 1887. pp. 36. 4. From American Naturalist, Department Microscopy:—1. *Albuminized Felt Tablets for Mounting Anatomical Preparations.* By H. Dewitz. 2. *The Napels Water Bath.* By Mayor, Giesbrecht & Vosmaer. 5. *The Indebtedness of Photography to Microscopy.* By A. Clifford Mercer, M. D. New York. 1887. 6. *Scientific Fact and Scientific Inference.* By H. W. Conn, American Naturalist. Sept., '87. 7. *Limits of Organic Evolution.* By H. W. Conn, American Naturalist. May, 1886.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted, Diatomaceous earth from Mégillanes, Bolivia, South America. Can give in exchange either Diatomaceous earth from New Zealand or cash.
E. MICHALEK,
I. Fleischemarkt, No. 1, Vienna, Austria.

Mounted sections of Fœtal Lung (5 months), sections across entire lobe, $\frac{1}{20000}$ in. thick, beautifully stained, in exchange for first-class pathological slides.
W. C. BORDEN, M. D., U. S. A.,
Fort Douglas, Utah.

Correspondence relative to exchange in microscopical material or prepared mounts.
HENRY L. OSBORN, Hamline, Minn.

Wanted, earths, recent diatoms, and miscellaneous objects for mounting. Only first-class material offered or desired.
MARY A. BOOTH, Longmeadow, Mass.

Fossil Diatomaceous deposits (marine) wanted from Bermuda, Virginia, Maryland, California, etc.
I. ELLIOTT, Ardwyn Villa, Aberystwith, Wales, England.

Labels for slides.
EUGENE PINCKNEY, Dixon, Ill.

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Carmine injections.

BY DR. W. C. BORDEN,

FORT DOUGLAS, UTAH.

Trouble with carmine gelatin fluids, when used for micro-injections, arises in two ways; either from an excess, or deficiency, in the amount of acid used to precipitate the carmine.

In the first case, the carmine will precipitate in a too coarsely granular form; while in the second, all the ammonia not being neutralized, the ammoniacal solution of carmine will diffuse through the walls of the blood-vessels Different formulas for carmine injection fluids attempt to overcome the difficulties named, by either stating the exact quantity of ammonia and acid to be used, or by the skill of the maker, who is to judge by sight or smell when sufficient acid has been added.

When the operator attempts to go by a formula giving definite quantities, he is often baffled by the varying strength of the ammonia. When he is not thoroughly experienced, and tries to make a fluid, trusting to his senses to

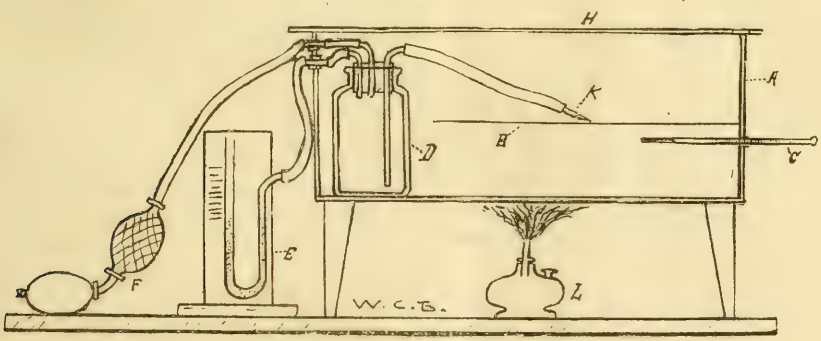

FIG. 5.—Injecting apparatus with modified injecting jar.*

inform him when the necessary amount of acid has been used, his knowledge gained by previous failures and successes being lacking, he will conclude, with many writers on histological technique, that experience is required in order that good injections may be made, and either give up in despair or waste valuable time in gaining the experience necessary.

* EXPLANATION OF THE FIGURE.

A. Bar for holding object during injection.
B. Shelf.
C. Thermometer.
D. Injecting bottle.
E. Atomizing bulb.
F. Manometer.
H. Glass cover.
K. Injecting canula.

All this may be obviated, and an inexperienced manipulator produce as good a carmine fluid as one who is thoroughly conversant with micro-injections by determining, before making the fluid, the exact amount of acid which it will take to neutralize a given quantity of ammonia; that quantity which is to be used in the fluid made. To this end, take a dram of the aqua ammonial, which is to be used, and add to it, gradually, with constant stirring, acetic acid, testing with blue litmus paper. The instant the paper changes to red stop adding the acid, and note the amount which has been used. Suppose that it is $1\frac{5}{6}$ drams, as was the case the last time I made up an injection fluid, then the proportion of acetic acid to ammonia will be 11 to 6, and if the entire amount of ammonia to be used be 4 drams, as in the formula to be given, then the amount of acid needed will be $7\frac{1}{3}$ drams. In this way the proper amount of acetic acid to ammonia may be found in any formula. Having had uniformly most excellent results with the following, I can unhesitatingly recommend it as one of the best, if not the best, of the gelatin carmine warm flowing masses:

CARMINE SOLUTION.

Carmine No. 40, ...	4 drams.
Aqua Ammonial Fort, ...	4 drams.
Water, ...	6 ounces.

Grind the carmine in a mortar, gradually adding the water, then add the ammonia, and heat gently until the carmine is dissolved.

GELATIN SOLUTION.

Gelatin, ...	$1\frac{1}{8}$ ounces.
Water, ...	$7\frac{7}{8}$ ounces.

Soak the gelatin in the water until soft, and then dissolve by heating.

Take five ounces of the gelatin solution and add to it the solution of carmine. Add to the remainder of the gelatin solution sufficient acetic acid, as found by previous trial, to neutralize the 4 drams of ammonia contained in the carmine solution. Heat the solution containing the carmine and that containing the acid to about the same degree, by placing the bottles containing them in a pan of water kept hot on a stove or over a lamp. Add gradually, with constant stirring, the gelatin solution containing the acid to that containing the carmine. Filter while hot through two thicknesses of flannel.

The fluid can be poured into the flannel shaped into a bag, when pressure on the sides of the bag will cause the contained fluid to pass through the cloth. Add 4 drams of chloral hydrate, and shake until dissolved.

The chloral will preserve the mass for quite a long time, but, if it is to be used within a day or two, the chloral is not necessary. A mass, made up by the formula given, is sufficient in amount to inject a small cat or rabbit entire. Should a mass be needed only for a single organ, the quantity of all the ingredients can be reduced, retaining the relative proportions.

In my experience injection of the whole animal gives the best results, except when special injections of a single organ is to be made with two fluids, when careful injections of the organ itself is better. In all cases a manometer should be used, together with some form of constant pressure apparatus. A syringe cannot be recommended, but the injecting jar of Prof. Gage is very useful, and less complicated than a water pressure apparatus. One can easily be extemporized out of a wide mouth bottle, and fitted with a manometer made from a piece of bent glass-tubing fastened to an upright board, with a scale in inches or millimeters marked on it. The only other articles necessary are a tin box, with a shelf inside, on which to lay the animal while injecting; a sheet of glass large enough to cover the box, a thermometer, a

few feet of rubber and glass tubing, and a couple of spring clamps for closing the tubing, when it is necessary to stop the flow. The whole apparatus, when put together, to be as shown in the figure. With good atomizer bulbs I have had no difficulty in maintaining a pressure of 100 millimeters while injecting.

The injecting canula, for fastening in the blood-vessel, can be made from a small glass tube, by heating it over an alcohol lamp, and drawing it out so that it will be decreased in size just back of the point. This will prevent its slipping out of the blood-vessel when tied in. It is better, however, to have brass canula and stop-cocks, such as are furnished with Beck's injecting syringe, and which may be bought of any dealer in microscopical goods.

Before making an injection the apparatus should always be arranged, and then tested by closing the exit tube and gradually raising the pressure to 100 millimeters, so that any defects or leaks may be found and remedied before the injection is begun. Before killing the animal the box is filled below the shelf with water at 40° C, and a lamp placed underneath to keep the temperature at that point. The melted injecting mass is then poured into the injecting bottle, in order that it may attain the same temperature. About 12 ounces of a $\frac{3}{4}$ per cent. salt solution is poured into another bottle, also arranged with injection tubes and placed in the box. The animal is chloroformed and, before the action of the heart ceases, a window is cut in the thorax, the pericardium opened, the heart drawn out with a tenaculum, and its apex cut off. The escape of the blood is aided by holding the animal up, first by the head and then by the tail. As soon as the blood ceases to flow a canula is passed through the left ventricle into the aorta and fastened in by a ligature passed around the artery. The animal is then placed in the box, the canula connected with the delivery tube of the bottle containing the salt solution having first forced the solution through the tube until all air is displaced, the box covered with the glass, and the solution injected at a pressure of 50 millimeters, until it escapes clear from the right side of the heart.

The canula is now disconnected from the bottle of salt solution and connected with that containing the carmine fluid. Beginning the injection with a pressure of 50 m.m., this is gradually increased to 100 m.m., but no more. After a time, the veins entering the right auricle may be tied and the injection continued until the eyes, tongue, ears, and feet show by their color that the capillaries are filled. The aorta is then ligated, and the animal placed in ice water, or a refrigerator, to remain until cold, when the parts desired are to be removed and hardened in alcohol. This method will, of course, not inject the lungs. They must be injected through the pulmonary artery, and then distended by injecting the air passages with alcohol through the trachea.

Studies for beginners.—I.

By H. L. OSBORN.

THE YEAST PLANT.

The winter weather need not deter us from using the microscope. It is therefore proposed to narrate a few easy and yet interesting studies which may now be prosecuted. To be sure the ponds are frozen and smaller forms of life have sought seclusion or been overtaken by death. But they have left traces behind them and can be hunted out, revived, and made to reveal many secrets. The yeast plant shall serve this purpose first.

How many persons know that yeast is a plant? It is a very small one,

being only about one thousandth of an inch long, and of a very simple form. It is only an oval body with very few parts. And yet, small as it is, it can do wonderful things which no unanimated object can imitate.

To see what yeast is like you must first procure a cake of Gaff. Fleischmann & Co.'s compressed yeast, and be sure it is very fresh, or get a penny's worth of the fluid yeast from a baker. The two are much alike, the latter being merely diluted with water. If you have the compressed article, take, of the grayish damp yeast within the wrapper, a very small amount, a mass say the size of a buckshot, put it in a watch-glass and add ten or twenty times its volume of water. Then clean a slide and cover-glass very carefully; place in the centre of the slide one drop of the thinned yeast, carefully drop the cover-glass over it, and, if the fluid does not extend to the edge of the cover, add at the edge a little more water from a supply you should have on your table. Your yeast is now prepared for a first look. Place it on the stage of your microscope, which must be horizontal, or only slightly inclined, else the yeast will be likely to gravitate out of the field, and examine the fluid with a low power (about 50 diameters) to learn its composition. You at once see that it is a transparent medium, the water, in which a myriad of minute specks are scattered. Closer study shows that the specks are of two sizes, one sort quite large and not very numerous, also bright and shiny in most lights (these are not the yeast but starch grains), and a second kind, which are far more abundant than the starch grains, and very decidedly smaller, indeed so small that you may at first fail to see them; these are the yeast plants, the active portion of yeast.

If there is any doubt about which are the starch grains and which the yeast plants, one may easily settle the question by using the *iodine** solution, which can be got from a dealer in optical goods. To use this, place a drop of the iodine on the slide at the edge of the cover, so that the solution mixes with the yeast fluid. Place a bit of clean blotting paper ½ inch square on the opposite side, and allow it to soak up the fluid from under the cover-glass and to draw the iodine under in its place. This process is a convenient one to remember by the name of 'irrigating.' After you have irrigated the iodine through, then irrigate some water through after it. A good many of the starch grains and of the yeasts will have been washed out, but enough are left for observation. On looking again with a low power there will be seen uncolored grains of small size, and very dark blue or black grains of larger size. The blue ones are the starch and the uncolored ones the yeast.

The yeast grains are not really uncolored with the low power, though they seem to be so. Examine them with a power of 450 diameters, or thereabouts, and they will be clearly seen. They seem to have very little 'to them.' Close examination will show that they are made up of a substance which 'stains' brown with the iodine and is known as *protoplasm*, which is enveloped by an outer protecting coat called the *cell-wall*, that the protoplasm does not wholly fill the cell but leaves a clear space of variable size and position, the *vacuole*, and that the protoplasm which is not clear but faintly granular contains numerous bright or dark little specks which are *fat droplets*. The yeast plant thus appears to have a few different parts. We shall next inquire how to see each of these more clearly. And since we think of living things as doing something, at least growing, it will be interesting to see what the yeast plant can do.

(*To be continued.*)

* The iodine which the biologist used is made by saturating a small amount of water with potassic iodide, then adding a few crystals of iodine. In use the fluid should be diluted to a light cherry brown color. The strong solution is not as effective as a weaker one, which may need to be passed through several times.

Biology of fresh-water Sponges.—I.*

By EDWARD POTTS.

PHILADELPHIA, PA.

In constitution and general appearance the fresh-water sponges resemble many of those of a marine habitat, excepting in one particular. This crucial point is the presence, during certain resting seasons, in most of the former, and the absence from *all* the latter, of those 'seed-like bodies' that have been known and described by various authors under the names of ovaria, gemmules, statoblasts, statospheres, sphærulæ, etc. In the past I have generally avoided the use of the familiar word statoblast, as it did not seem clearly proven that the function of these 'seed-like bodies' of the sponges was identical with that of the statoblasts of the polyzoa, etc.; and have used the terms statospheres, or sphærulæ, as suggesting merely their general appearance. Latterly, however, I have concurred with several European writers in the use of the old term, gemmules; the principal objection to which is that with some persons the name may seem like a return to the exploded vegetable theory of sponges. It is hardly necessary to say that this idea is not intended.

In shape these gemmules are nearly spherical; they are about $\frac{1}{50}$ of an inch in diameter, or as large as very small mustard seeds. They are found sometimes in continuous layers, as at the base of encrusting sponges; sometimes they rest singly in the interspaces among the skeleton spicules; again, they occur in groups of a dozen or less, sparsely scattered through the sponge mass, or in smaller, denser groups, closely enveloped in a compact cellular parenchyma. Their principal coat, presumably of chitin, encloses a compact mass of protoplasmic globules, each of which is charged with numbers of discoidal particles, whose function, though all important, it is not my intention to discuss in the present paper. A circular orifice, rarely more than one, through this chitinous coat, sometimes, though inaptly, called the hilum, should be known as the foramen or foraminal aperture. Through it, at the time of germination, the above mentioned protoplasmic bodies make their exit, crawling by an amœboid movement, and spreading out on every side. In a few hours the infant colony may be seen producing aqueous currents, developing and arranging skeleton spicules, and in every way living the life of a young sponge. The foraminal aperture is rarely plain; more frequently it is infundibular, having a slightly raised and expanded margin; while in still other species it is prolonged into cylindrical or funnel-shaped tubules.

In most species, possibly in all under normal conditions, the chitinous coat is surrounded by a 'crust,' composed of air cells, often so minute as to be with difficulty 'resolvable,' even with a high power of the microscope; in other species so large as to be readily discerned by the use of a low one. In the first instance it has been called a 'granular,' in the other, a 'cellular' 'crust.' In this are imbedded the spicules which are relied on to determine the generic classification of these sponges.

To recur for a moment to the resemblance stated to exist between the fresh water and *some* of the marine sponges,—we can see no obvious reason why *all* the marine forms should not have their representatives among those belonging to fresh water; but it is a fact that all of the latter, as yet discovered, are *silicious*:—that is, the skeleton or framework (corresponding to the elastic fibre of which commercial sponges are composed), upon which the slime-like sponge flesh, known as 'sarcode,' is supported, and through whose interstices the currents meander, is composed of silicious spicules, slightly

* Reprint of the introduction to a monograph of the fresh-water sponges read before the Philadelphia Academy, May 31, '87.

bound together by an almost invisible quantity of firmer sarcode or perhaps of colloidal silica.

To form the main lines of this skeleton structure the spicules, averaging about $\frac{1}{100}$th of an inch in length, are fasciculated in bands made up of several spicules, lying side by side, and somewhat overlapping at their extremities; the crossing lines being formed of more slender fascicles, or even of single spicules. In the different species these 'skeleton' spicules vary in size, in the shape of their terminations, and in their more or less spinous character; but while these differences serve, in some degree, as specific guides, they are not sufficiently constant or positive to form a basis for generic arrangement.

Besides the skeleton spicules, a second class, known as 'dermal' or flesh spicules is found only in some species and in greater or less numbers, either lying upon the outer 'dermal' film or lining the canals in the deeper portions of the sponge. They are almost always much smaller than those of the skeleton and are never fasciculated or bound together in any way. A third class of spicules is composed of those before mentioned as embedded in the 'crust' of the gemmules, and form what may be regarded as their armor or defensive coating. These gemmule-spicules represent two principal and several subordinate types, which have been selected by Mr. Carter to define the different genera into which he has divided the single genus *Spongilla* of the earlier authors. His method of classification will be given later.

The sponge in its entirety as a growing organism can generally be easily recognized by the collector, after he has escaped from the thraldom of the idea that any fixed growth, of a more or less vivid green color, must be a *plant* of some kind. Of course the mosses and confervæ will be rejected after examination, upon the evidence given by the leaves of the one and the smooth slender threads of the other. If doubts remain as to any specimen, the presence in it of efferent or discharging apertures, like those of the commercial sponge, if it is really a sponge, may serve to dispel them, and still more convincing proof will be given by the use of a pocket lens, in detecting the points of multitudinous spicules thickly studding the surface. When, in addition to these guiding features, the spherical gemmules just described are found within or under it, there should be no further hesitation.

The green color spoken of is common and characteristic; yet it is not universal, but closely dependent upon the quantity or quality of the light received. When a sponge has germinated away from the light and has grown upon the lower side of a plank or stone, it will be found nearly white, gray, or cream colored. As it enlarges and creeps around the edge and up into the full sunlight it assumes a delicate shade of green, deepening as the exposure increases, till it attains a bright vegetable hue. Even in the sunlight, however, some species are never green.

These organisms have occasionally been discovered growing in water unfit for domestic uses; but as a rule they prefer pure water, and in my experience the finest specimens have always been found where they were subjected to the most rapid currents. The lower side of large, loose stones at the 'riffs' or shallow places in streams; the rocks amid the foaming water at the foot of a mill-dam fall; the timbers of a sluice-way, the casing of a turbine waterwheel, or the walls of a 'tailrace' beneath an old mill;—in all these places they have been found in great abundance and of a very lusty growth. Of all discouraging situations it is almost hopeless to look for them in shallow water having a mud bottom. Mud is their great enemy, as gravity aids their natural currents to fill the cavities with earthy matters that soon suffocate them, because the latter are too feeble to throw them off. Of course in any body of water liable to be charged with sedimentary material, the principle

of natural selection favors those growing on the lower side of their bases of support, which protect them from the intrusion of the heavier particles.

For that reason perpendicular and water-logged or floating timbers, submerged stumps of trees, and branches drooping into the water from trees or bushes along the banks, are favorite locations. They do not disdain more temporary support, such as weeds and water grasses. I have received from a friend, specimens growing upon water plants that wild ducks had torn from the bottom, and that were found floating upon the surface of Lake Michigan. Through the clear water of our northern lakes, we may often see them lying in slender lines upon the leaves of submerged weeds, or in beautiful cushion-like masses upon the stones or gravel.

In my explorations I have had much satisfaction in the use of a long pole, to which was attached a small net, with one part of its edge shaped into a scraper, like a garden hoe. This enabled me to examine the surface of timbers at a depth of eight or ten feet and to tear off and bring up sponges from that depth; beyond which all is to me an 'aqua incognita.' Biologists labor at some disadvantage in studying the fauna of our fresh water, as compared with the facilities offered them in collecting ocean subjects. The nets and dredges of many exploring expeditions have, at least, *begun* to acquaint us with the inhabitants of the 'deep sea;' but who knows anything about the fauna or the flora of our deep fresh-water lakes, or even of our larger streams? The largest specimens of this group ever reported were dredged from the bottom of Lake Baikal in Central Asia (*Lubomirskia*). I know of no similar attempts to collect them elsewhere. It is to be hoped that means may be found ere long to make such explorations, which must result in an increase of knowledge in many lines. Meantime no opportunity offered by the accidental or designed drainage of artificial reservoirs should be neglected. I have spent hours of great pleasure and profit while groping around the distributing reservoirs upon Fairmount Hill, Philadelphia, at times when the water was drawn off for cleaning or repairs.

One further point as to methods of collecting and I shall finish this section of my subject. Unless our sponges are large, it is difficult to detach them without mutilation from the rough surfaces of stones. It is therefore preferable to gather, when possible, those growing upon wood, which may be scraped or chipped without injury to them. It is essential to secure the very lowest portions, as it is there the gemmules often abide.

The proper season for collecting fresh-water sponges, in waters of the temperate zone, depends upon the purpose of the collector. If it is his desire to gather cabinet specimens merely, for the identification of old or the determination of novel species, it is hardly worth while to begin before July. As with the flowering of plants, the maturity of different species of sponges is attained at various dates, between mid-summer and late in November. The essential point is, that the gemmules and their armature shall be fully perfected; and when that condition is attained in any specimen, there is no reason for further delay.

I would, however, recommend to intending students a far higher object for their ambition;—that is, the study of the physiology and life history of sponges as members of a sub-kingdom whose position has been greatly questioned and whose character, derivation and subsequent evolution are very important and perplexing topics. I would have such workers search for and examine them at all seasons of the year (even in mid-winter, when I have never failed in suitable situations to find some in a growing condition), keeping memoranda as to each species separately; noting the date of their germination or earliest appearance, the locality, elevation, temperature; rapidity of growth at different seasons; time and manner of formation of

gemmules; stability or decadence during the winter; modes of distribution and progression, whether always down stream or by other more adventitious methods; what becomes of the gemmules upon reaching salt water, and the thousand and one problems that go to make up the life history of any animal form, and that, in this instance, have been very little studied. I am particularly anxious that some competent person should undertake their study in the briny, brackish and the fresh-water lakes, pertaining to what is known as the 'Great Basin of the West,' with a special view to ascertain the conditions under which they form 'protected gemmules' in such localities. By this means, light may possibly be thrown upon the problem of their possible derivation from the marine sponges.

Great pleasure and profit may be attained in the same direction, by germinating the statoblasts or gemmules under artificial conditions, and studying the development of the young sponges by the aid of as high powers of the microscope as the ingenuity of each student may bring to bear upon the subject. I take the liberty to copy from the Ann. and Mag. Nat. His. 1882, p. 365, Mr. Carter's directions for germinating statoblasts, which will be found valuable. 'To obtain the young spongillæ it is only necessary to get a portion of an old living specimen bearing statoblasts, and, having taken out a a few (six to twelve) of the latter, to roll them gently between the folds of a towel to free them from all extra materials as much as possible, place them in a watch-glass so as not to touch each other, with a little water, in a saucer or small dish filled with small shot to keep the saucer upright, and covering them with a glass shade, transfer the whole to a window bench opposite to the light. In a few days the young *Spongilla* may be observed (from its white color) issuing from the statoblast and gluing the latter as well as itself to the watch-glass, when it will be ready for transfer to the field of the microscope for examination, care being taken that it is never uncovered by the water, which may be replenished as often as necessary; but of course the object-glass (when $\frac{1}{4}$ inch with high occular is used for viewing the minute structure) must admit of being dipped into the water without suffusion of the lens.'

(To be continued).

The staining of animal and vegetable tissues.*—III.

By ARTHUR J. DOHERTY,

MANCHESTER, ENGLAND.

NIGROSINE FOR COLORING NUCLEI OF VEGETABLE CELLS.*

'M. Errara finds nigrosine an excellent reagent for the nuclei, which are colored a very deep blue, and stand out very clearly, the rest of the cell remaining practically colorless.

'Nigrosine is one of the derivates of tar, and belongs to the class of indulines. It is soluble in water, and insoluble in alcohol and ether; and for coloring should rank with safranin, methylgreen, and other recognized agents.

'The preparation should be placed for a short time in a solution of nigrosine, and then washed in distilled water until the water takes up no more coloring matter. It can then be mounted in glycerin, or in balsam or dammar. The former method is preferable if it is desired to study the protoplasm, and the part of the nucleus formed of achromatine (of Fleming); the second should be adopted for the examination of chromatine (= nucleine), as the grains of starch which hinder observation are rendered invisible.'

* Journal Royal Microscopical Society, for 1881, p. 839.

ANILIN DYES.

The following list of anilin colors, though not by any means an extensive one, includes all that I have found really useful in histological work. It is to be regretted that many biologists appear to have lost sight of the true object of histological research in their zeal to discover new staining fluids and processes, and the number of these now recommended is somewhat appalling. Endeavors to advance any art or science are indeed always praiseworthy, and deserve every encouragement; but I must confess that it seems to me the science of histology is retarded in its progress by first one and then another 'rushing into print' with descriptions of new processes which have no points of superiority whatever over many existing methods, and are, in fact, much inferior to others.

It will be seen that several of the colors enumerated are soluble both in water and alcohol; as a general rule the aqueous stain is the most useful. Eosin is not an anilin dye; but it is convenient to describe its properties along with the anilins.

Soluble in water.	*Soluble in alcohol.*
China blue—rosanilin.	China blue—gentian-violet.
Bismarck brown.	Malachite green.
Malachite green.	Iodine green.
Safranine.	Anilin blue-black.
Magenta.	Rosein.
Anilin blue-black.	Pure opal blue.
Methyl-anilin.	Eosin.

China blue, in a 1% aqueous solution, is a useful stain for tissues injected with carmine, with which it contrasts more strongly and pleasantly than logwood. Dr. Heneage Gibbes has found it suitable for stomach and spinal-cord.

Bismarck brown.—This is a useful color for gland tissue, and may be used in combination with eosin, rosein, or anilin blue in double-staining.

Malachite green.—A fine rich color, and useful in combination with carmine in double-staining vegetable sections.

Safranine.—I have found this color useful for staining nuclei in vegetable sections. A 1% solution is a useful strength, and the sections must be well washed after staining; clear in oil of cloves, and mount in balsam.

Magenta.—A $\frac{1}{10}$% solution is useful for staining fresh tissues.

Anilin blue-black.—Of all stains this is, perhaps, one of the best for brain and spinal cord. Dissolve a little of the color in water, and add sufficient strong methylated spirit to make a $\frac{1}{10}$% solution. Mount the preparations in Canada balsam.

Methyl-anilin.—The peculiarity of this stain is that, in contact with certain tissues, it decomposes into two shades of violet, red and blue; the latter acts upon the nuclei, while the former colors the formed material. In amyloid degeneration the red violet acts upon the diseased parts, while the blue violet colors the unaffected tissues. Mount the sections either in potassic acetate or in glycerin.

Iodine green.—This is one of the most useful of the anilin colors, especially in double-staining. It has been recommended for almost every kind of tissue, and to enumerate the different ways in which it has been employed would be no little task. I shall refer to this color, and other anilin dyes, under the head of double-staining.

Rosein.—A useful color in multiple-staining. I have found this stain superior to all others for staining vegetable tissues which have been treated with

acid. A 5% solution should be used for this purpose, the tissues being afterwards rinsed in rectified spirit, cleared in clove oil, and mounted in Canada balsam.

STAINING BACTERIA.

The profound thought which, during recent years, has been given to the microbe theory of disease, and the refined investigations which have been conducted in this department of pathology (or biology), have resulted in the discovery of many methods of staining bacteria. Three processes, which I have myself practised with success, and which I can thoroughly recommend, both from their simplicity and the excellent results which they yield, have already been published in this JOURNAL.*

DOUBLE OR MULTIPLE-STAINING.

We now pass by an easy transition to the art of double, treble, and multiple-staining, or the differentiating the various structure or tissues in a preparation with different reagents.

It is commonly but erroneously supposed that any tissue will take any stain; that this is not so ample proof can easily be given. The following statements may be considered as axioms:—

1. A stain will color a tissue unless there is an affinity between the tissue and the stain.

2. No simple tissue will take a double-stain unless the cells composing it are nucleated. In this case it is possible to stain the nucleus with one color, and the remainder of the cell with another.

3. If a preparation is composed of two or more distinct tissues, it can easily be stained in two or more colors; but two or more colors cannot be put into a preparation unless there is a tissue for each of them.

These considerations lead to the conclusion that, as every tissue will take a stain, many sections or preparations could be stained in as many colors as there are tissues entering into its composition, if it were only possible to isolate the action of staining reagents to each of those tissues separately.

We have already seen that methyl-aniline yields a double stain in contact with certain tissues. This property is also possessed by picro-carmine, and indeed, *to a certain extent*, by almost every coloring reagent it is possible to employ, though the decomposition is not so strongly marked as with the two substances named.

Picro-carmine, or picro-carminate of ammonia, was first introduced as a stain for histological purposes by Ranvier. It decomposes into red and yellow, and hence is a strongly differentiating reagent for many tissues.

ALCOHOL PICRO-CARMINE FOR VEGETABLE TISSUES.

The following preparation of picro-carmine is very valuable for staining vegetable tissues:—

A. Dissolve ½ gramme of picric acid in 30 cc. of absolute alcohol. B. Dissolve ⅛-gramme of carmine in 3 cc. of strong liquor ammoniæ, and add 27 cc. of water. Add A. to B. The quantities should be measured exactly; and, if this is done, the solutions, on being mixed, will throw down no precipitate.

The process of staining with this solution is peculiar, and I shall therefore describe it fully.

The sections, after being bleached and washed, must be soaked in rectified spirit, or preferably in absolute alcohol, for half an hour; they are then transferred to a watch-glass containing some of the stain, and covered to protect them from dust. In from fifteen to sixty minutes the staining will be

* Dec., 1887, page 227; Jan., 1888, page 14.

completed. Pour off the stain, and cover the sections with rectified spirit. The spirit must not be filtered, but must be poured on to the sections, and the watch-glass must then be taken in the hand and turned rapidly round and round for about a minute. After this the spirit is poured off quickly, and the sections are now covered with an alcoholic solution of picrate of ammonia, which is prepared as follows :—

Make a saturated solution of picric acid in absolute alcohol; to 40 cc. of this solution add 50 cc. of strong ammonia, and slowly evaporate the mixture down to dryness. Make a saturated solution of the resulting crystals in absolute alcohol.

The sections are left in this solution for five minutes; they are then rinsed quickly in absolute alcohol or rectified spirit, cleared in oil of cloves, and mounted in Canada balsam. If a section is now examined under the microscope, it will be seen that it is stained most beautifully and selectively—the picric acid producing a golden yellow, and the carmine a pink or pale red color, very soft and pleasing to the eye.

For some years I have employed a modification of the above process for staining vegetable tissues in carmine and green, the old processes being both tedious and not always yielding satisfactory results.

The sections are treated as described, down to the washing after staining with the carmine; they are then transferred to a glass beaker, containing 90% alcohol at 100° Fahr., and are kept at this temperature over a water bath for half an hour; or if time is no object, the sections should be washed for several hours in successive changes of cold alcohol. This treatment almost totally removes the yellow stain. The sections are then stained for one hour with a strong alcoholic solution of iodine green, washed in rectified spirit, cleared in oil of cloves, and mounted in Canada balsam. Two precautions must be observed :—(1) the sections must not be kept in the spirit used for washing more than two or three minutes; and (2) they must be mounted within one hour after being transferred to the clove oil.

It may happen that the iodine green employed tends to combine with the carmine, the beautiful color of which is thereby completely spoiled. This action of the green may be partially corrected by washing the sections in alcohol acidulated with a few drops of acetic acid; but it is much better to try different samples of iodine green, until one is found which leaves the carmine perfectly clean.

A very beautiful carmine and blue stain is obtained by substituting anilin or pure opal blue, in an alcoholic solution, in place of the iodine green in the above process.

In sections of the stems and petioles of many palms and other monocotyledons, certain cells in the fibrovascular bundles (possibly the spiral on pitted cells—I have not examined a longitudinal section) persistently retain the yellow produced by the picric acid, and a perfect triple stain is thus obtained, which is seen most clearly under a quarter-inch objective.

The following combinations yield very beautiful results in many vegetable sections :—

1. Eosin and iodine green.
2. Rosein and pure opal blue.
3. Bismarck brown and pure opal blue.
4. Bismarck brown and violet.
5. Iodine green and Bismarck brown.
6. Eosin and methyl-blue.

PICRO-CARMINE FOR ANIMAL TISSUES.

Dissolve 1 gramme of carmine in 50 cc. ammonia, and add 200 cc. of a cold saturated solution of picric acid. Evaporate the mixture down to 100

cc., and filter it before use. Place the objects in the stain, and leave them for twenty-four hours; they are then taken out one at a time, dipped in water, and mounted in glycerin or Farrant's medium.

(To be continued.)

A new injecting mass.

By MAURICE N. MILLER, M. D.,

DIRECTOR OF HISTOLOGICAL LABORATORY, UNIV. MEDICAL COLLEGE, NEW YORK CITY.

I have, during the past ten years especially, been using very little artificially injected tissue in teaching, for the reason, first, that vascular channels so filled are usually distorted by the pressure necessary to their complete injection; and, secondly, the opacity of the injecting material obscures the vascular walls.

I have, rather, insisted that the student should by persistent effort become acquainted with the histology of vascular coats as they appear in undisturbed relation. I would, by no means, discard injections altogether; much of our present knowledge of organized structure has become possible only by the aid of such preparations. But I would encourage the student to believe that the most valuable sections are not those which have had their vessels plugged with opaque gelatin—arteries red, veins blue! (?) The students under my instruction are provided with sections which they can duplicate or equal when they go home and commence working by themselves. And I know it is a very proud moment for the young physician when he finds himself able, with the aid of a few simple and always obtainable appliances, to make, stain, and mount a section—and one which will enable him to say, *e. g.*, whether the minute speck of growth which he has removed from a patient is a harmless wart or a deadly cancer. Let us, then, beg the beginner, with all the earnestness with which I am capable, to let injections alone for a year, at least; and devote such time as you are able to spare to the acquirement of the technique necessary to hardening, cutting, staining and mounting.

These remarks may seem singular as prefatory to a description of an injecting method. I am perfectly well aware that the student will not pay the slightest attention to what I have said, but will immediately get a copy of *Beale*, and borrow the farina-kettle from Bridget, make some carmine gelatin, sacrifice a neighbor's pet grimalkin and fail utterly, miserably. And it's ten-to-one that he never attempts injecting again—that is to say, for histological purposes. Now I have devised an injecting mass which is intended to be made on the day following this experience.

First procure some thin, clear, colorless French gelatin. You will find it in sheets about 3 × 8 inches, with crossed markings. Don't use Cooper's or Cox's. They are worthless for our purpose.

To one ounce of gelatin add ten fluid ounces of cold water. Allow the gelatin to swell for an hour, and then place the vessel containing the whole in a kettle of boiling water and allow it to remain until the gelatin melts thoroughly. Strain through previously moistened flannel into, preferably, a flask.

While yet warm and fluid, pour about half of the gelatin into another glass vessel. Dissolve in one half two grains of dry common salt; and in the other half ten grains of nitrate of silver. Should the gelatin become stiffened by cooling it must be warmed, and so kept fluid. When all is dissolved mix the two gelatin solutions and shake briskly for from three to five minutes. Add ten grains of citric acid and keep the gelatin warm until the former dissolves. This is the injecting mass and is ready for use. If the means are at

hand for filtering first through paper the solution will be clearer, although this is not absolutely essential.

We have a gelatino-chloride of silver emulsion, with a slight excess of silver. It need not be kept from the light, but is best, I think, when fresh. I have some dried on glass plates which I believe will keep indefinitely.

The particles of chloride of silver are exceedingly minute—indeed with a quarter inch looks like a solution. Of course it must be used warm like all gelatin masses. The color in the mounted section is of a beautiful purple and perfectly translucent. The differentiation between arterioles or venules and capillaries by its means is perfect,—as the larger the vessel, the darker the color of the mass. I have not yet found it necessary to take any special pains to darken the injection by exposure to light—the excess of silver seems sufficient to cause the reduction of the chloride. There is absolutely no such word as fail in connection with its preparation, although the order given must be observed with reference to the citric acid. This must be put in last, and this is the only important matter. Certainly metal vessels must not be used as the silver salt would act upon them. Do not infer that the mass is spoiled if partly darkened before use.

I have had this in use for nearly two years, but have not made it public, as I have not been able, until quite lately, to spare the time to thoroughly test its properties. It will give me pleasure to suggest any further details if thought necessary.

410 E. 26TH STREET, NEW YORK.

Structure and function of the Mammary Gland.*

BY DR. MORGAN WILLCOX AYRES,
MONTCLAIR, N J.

The mammalian characteristic is found in the gland whose secretion is the destined food of the offspring, and which is usually found in relationship with the associated generative apparatus, assuming many and varied situations, at one extreme being inguinal, and at the other, and highest, pectoral.

Secretion of milk is the work of this specialized gland, and from simplicity to complexity of structure, a gradual differentiation is found in passing from the monotremata to man; its difference in genesis is more apparent than real; its function, always, elaboration from the mother's blood of the mammary secretion.

External appearance of position and number may mislead, yet the microscopical structure shows one general type, from the simple cluster of isolated follicles in the echidna to the elaborately formed gland of the highest mammalian.

Following the general law of glandular development, the human mammary gland is first seen about the third month of uterine life, in the form of a small projection from which processes radiate, giving rise to the glandular follicle and ducts.

The position and minute anatomy of the human female gland typifies, with few exceptions, the whole mammalian series.

There is one gland upon each side of the median line, between the sternum and axilla, reaching from the third to the seventh rib.

They may be divided into internal, the proper secreting structure, concealed under the skin, and the external, the nipple and surrounding areola; the whole resting upon the ribs, encapsuled by a strong fibrous envelope, or suspensory fascia, which sends prolongations into the gland itself, forming fibrous trabeculæ, dividing the organ into many compact single glands; like-

* See report of meeting of Essex Co. (N. J.) Mic. Soc. Jan. 5, '88, p. 57

wise the suspensory ligament sends attachments forward to the skin, and behind along the whole pectoral aspect.

The gland itself consists of many lobes, made up of lobules bound together by connective tissue, supplied with blood-vessels, nerves, and lymphatics. The ultimate lobules consist of foliated vessels, the true secreting portion of the gland, termed acini, or glandules, which open into the smallest of the lactiferous ducts, these uniting form larger ducts, which finally end in a single canal. These converge toward the areola, beneath which they form dilatations, which act as reservoirs for the secretion; from these they become contracted and follow out to the nipple a straight course, opening upon the external surface by an indefinite number of orifices.

It is characteristic of the mammary gland that it is subject to varying changes, normal, rhythmic, and directed toward a definite end. To appreciate these changes in the parturient female, the condition of the gland in the embryo must receive attention, for its formation is an embryonic act, and upon the birth of the fœtus, the result of formative and functional activity is found in the breast of the babe.

The structure in the embryo will be found to exhibit a series of changes, which may be compared with the successive changes of a periodical rise into activity.

The acinus in embryonic development is believed to begin as a small group of cells, at first nuclear, but afterward invested with a quantity of cell substance. The circular boundary of the acinus is next determined by a vacuolation of the cells. The vacuolated cells burst their membranous walls, and discharge their contents: the evacuated fluid being the secretion of the mammary gland of the fœtus. The same result follows in pregnancy, the acini undergo a developing process, and, when the term is ended, a fluid is discharged in a larger quantity.

The embryonic development of the gland is an epitome of subsequent structural and functional states of rest and activity.

Rest, or functional inactivity of the cellular elements, means complete shrinkage of acini, partial obliteration of the ducts, and a proliferation of the connective tissue between the lobules. Incited by the irritation of uterine functional changes, the future condition of the gland is one of progressive activity, coincident with the beginning of pregnancy and occupying the entire period of gestation.

The progress of the activity of the gland is attended by a gradual assumption of cellular individuality, the marked enlargement of the whole contour of the gland, the lobules full and round, the fibrous trabeculæ thin and having now a secondary position. The floor of the acini is covered with a layer of cells, in more or less regular order.

The milk of the first seventy-two hours after parturition is known as colostrum, it being the result of fatty degeneration of the innermost cells of the acini, and their downfall leaves a cavity, afterward to be filled with milk; the physiological degeneration of epithelial tissue looking toward a specific end.

Notices of New Methods.—II.

By GEORGE C. FREEBORN,
NEW YORK CITY.

Celloidin-Paraffin Imbedding.* Kultschizky.—The specimens are placed, from alcohol, in a mixture of equal parts of alcohol and ether for one hour. Then for twenty-four hours in a strong solution of celloidin.

* 3 f. w. Mikros., iv, p. 48, 1887.

The specimens, saturated with celloidin, are placed in oil of origanum. Then in a mixture of oil of origanum and paraffin heated to 40° C. Then in melted paraffin.

The time which the specimens are to remain in the oil of origanum, in the paraffin mixture, and in the melted paraffin, depends upon the nature and size of the specimens. The imbedded specimens can be kept in the dry state, and it is not necessary to use alcohol in cutting.

——o——

Carmine Staining.* Kultschizky.—

1. *Acid Chloral Hydrate Carmine.* Chloral hydrate 10 gms., Hydric chloride 2 per cent. solution, 100 c.c. To this fluid is added 0.75 to 1.5 gms. of pulverized carmine, and the mixture heated, in a flask, to the boiling point for one to one and a half hours. To prevent evaporation, the flask is fitted with a cork, through which a long glass tube is passed. The mixture is now allowed to stand, at the room temperature, for twenty-four hours, then filtered and the filtrate used for staining.

The author claims that this carmine solution stains protoplasm, nuclei, fibrous tissue, etc., different shades of red. If a sharp nuclei stain is wanted, then the sections are washed in a 2 per cent. solution of alum, when the nuclei take a violet tint.

2. *Neutral Chloral Hydrate Carmine.* This stain is prepared in the same manner as the above, except the hydric chloride is omitted. This carmine mixes well with Grenacher's alum carmine, whereby a double staining fluid is obtained, which gives red and violet shades. These solutions keep for a long time without becoming mouldy.

——o——

A New Staining Medium.† Gustav Plattner.—The author recommends a new black dyeing solution that comes from Russia, and which he obtained of Dr. Grübler, in Leipzig. According to the latter, it is a metal base combined with an acid of an organic nature. The dye, in dilute solutions, stains only nuclei, nucleoli, and axis cylinders; connective tissue, protoplasm, and myelin remaining uncolored. In concentrated solutions it stains, in shades corresponding to the degree of concentration, all tissue elements. For decoloration, alkaline solutions are used. Five or six drops of ammonium hydrate to a watch-glass of water makes a suitable decoloring fluid. Salts of the alkalies may also be used; of these, the author gives the preference to lithium carbonate in a saturated solution in water.

Sections are stained in the dye for a few minutes. Those of tissues hardened in Flemming's fluid require twenty-four hours. The time that they should remain in the decolorizing fluid depends upon the effect wanted and the intensity of the stain. By this method of staining, an intense black nuclei stain is obtained, which brings out the karyokinetic figures well. It is also a good stain for micro-photography.

Shellac Cement.‡

By W. N. SEAMAN,
WASHINGTON, D. C.

Take 50 grammes of *unbleached* shellac, add to it 50 c.c. of commercial alcohol, and then cover the mixture with an equal quantity of kerosene oil. Shake the mixture frequently for the first two or three days, and then set it away for a month, or until it separates into four layers, as follows, beginning at the top:—

* 3 f. w. Mikros., iv, p. 46, 1887.
† 3 f. w. Mikros., iv, p. 349, 1887.
‡ Presented at the 70th meeting Wash. Mic. Soc.

1. Kerosene.
2. A layer of woolly looking stuff.
3. Clear shellac.
4. Sediment.

By means of a pipette, or any other convenient way, draw off the shellac, and to each 50 parts of it add one part of boiled linseed oil. This will make a strong and lasting cement for attaching metal to glass.

EDITORIAL.

Bacterial origin of infectious disease.—Dr. G. M. Sternberg in an annual address as President of the American Public Health Association at Memphis, Tenn., in November, 1887, reviews the results of recent progress in medicine in this department. After stating the importance of well endowed laboratories for the proper study of disease, he mentions, as justifying them, the fact that in many diseases protection is undoubtedly secured by the use of attenuated virus. This has been done in the case of small-pox, anthrax, swine-plague, and pleuro-pneumonia with undoubted success, and 'the evidence in favor of Pasteur's inoculations for the prevention of hydrophobia is such that we can scarcely doubt that it has a relative value, notwithstanding the considerable number of deaths which have occurred among those who have been inoculated. The recent report of the English commission, made after a thorough investigation, is favorable to the method, which may perhaps hereafter be modified so as to give still better results.'

Four methods are known of attenuating the virulent potency of disease germs, viz., (1) by exposure to oxygen, (2) by exposure to heat, (3) by the action of certain chemical agents, (4) by passing through the body of certain animals.

It is now generally recognized that practical sanitation is only safe if in accord with our knowledge of the biology of micro-organisms, hence the immense importance of their thorough investigation. With respect to questions still under discussion, the author reviews the question of the cholera bacillus and its relation to the disease and the bacillus of croupous-pneumonia, and concludes with reference to the recent investigations of Counselman and Osler upon the germ of Laveran and its causal relation to malarial fever.

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Correction.—On page 214 of vol. viii of this JOURNAL we incorrectly spelled the name of the author of a convenient method for collecting tubercular spectum. The name which now reads Dr. H. Tholman should read Dr. Henry L. Tolman.

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Simplicity in great men.—There is nothing more striking to one who looks through Darwin's Life and Letters, recently published by D. Appleton & Co., than the absence of vainglory and self-praise. The universal testimony of those who know that great man, and now, after his death, the testimony of his own letters, is that he was satisfied with the opinion of those about him. He did not assert for himself his right to greatness. A friend of ours wrote to Mr. Darwin a number of years ago regarding an observation which he had made, which was an example of the doctrine of color variation due to the natural selection. The observation Mr. Darwin acknowledged, in a very pleasant personal letter. Professor Baird and Professor Gray, both recently taken from the scientific world, were men in whom this quiet and splendid simplicity was conspicuous. We cannot help thinking when we find a man asserting his right to greatness and general recognition, that he is somewhat unworthy of that he claims.

NOTES.

Dr. Jas. E. Reeves, of Wheeling, W. Va., whose ability in the use of the microscope in medical diagnosis has given him a high reputation, has decided to remove to Chattanooga, Tennessee.

Dr. F. L. Patton, a professor in Princeton Theological Seminary, has succeeded Dr. McCosh as President of Princeton College.

Prof. F. V. Hayden, formerly chief of the United States Geological Survey, died recently at his home in Philadelphia. He was engaged in geological work from 1853 until his resignation in 1886, except during war-time when he entered the army as a surgeon.

Prof. Asa Gray, the eminent botanist and professor of botany at Harvard College, died of paralysis, in Cambridge, Jan. 30th.

He was born in Paris, Oneida county, Nov. 18, 1810. He graduated at N. Y. Fairfield Medical College in 1831 with the degree M. D.; but he abandoned medicine and applied himself to the study of botany. He was appointed professor of botany in the University of Michigan, but before that institution went into operation he was elected Fisher professor of natural history in Harvard College. From the beginning of his career, his name has been associated with the progress of botanical science in America. His perspicacious mind, retentive memory, and untiring industry not only made him foremost in America, but one of the leading botanists of the age. In his numerous writings he showed equal ability in communicating elementary knowledge and in elucidating recondite theory. His elementary works are unsurpassed in the language for precision, simplicity and comprehensiveness. His labors are also recorded in numerous papers contributed to the leading scientific journals. Dr. Gray, with Dr. John Torrey, was among the first who arranged the heterogeneous assembly of species upon the sound basis of natural affinity. In 1838 he commenced, in conjunction with Dr. Torrey, the publication of a 'Flora in North America.' In 1848 Dr. Gray began his 'Genera of the Plants of the United States,' illustrated by Isaac Sprague, and in the same year the 'Manual of the Botany of the Northern United States.'

A Journal of Spiritualism.—Signor Giovanni Succi, of Florence, announces the appearance of the first number of 'Il corriere spiritico,' a thirty-two page monthly scientific review of spiritualism. Signor Succi promises that all the assertions made in the 'Corriere' shall be substantiated by material facts of a convincing nature.

Japanese Marine Laboratory.—On the west side of the bay of Tokio, Japan, a marine biological station has been established, of which an interesting account is given by Prof. K. Mitsukuri, in the *Journal* of the College of Science of the Imperial University. The neighborhood of Misaki has, it appears, long been a favorite collecting ground for naturalists, as all kinds of bottom are accessible, and 'beds which furnish the world-renowned *Hyalonema*' are not far off. With *Hyalonema* a species of *Pentacrinus* is brought up clinging to the fishing-lines. Mollusca are abundant, and crustaceans are largely represented. The main laboratory room is able to accommodate ten workers. The formation of the station is due to the liberality of the Department of Education and of the authorities of the Imperial University.

MICROSCOPICAL SOCIETIES.

Western Society of Naturalists.

On Dec. 29 a number of naturalists met at Indianapolis and organized a society of this name. They adopted almost entire the constitution of the Eastern Society, with some few exceptions, such as placing the annual meeting in October. The following persons were elected to office:—President, S. A. Forbes; Vice-Presidents, W. J. Beale, C. O. Whitman, H. L. Osborn; Secretary, J. S. Kinsley; Treasurer, J. M. Coulter.

It is the desire to restrict membership so as to make it embrace only the best workers of the northwest. This society has it in its power to do a great deal of good by furnishing a standard of work in Zoology, Botany, Geology, Chemistry, etc., by which bad work shall be unable to receive recognition.

SAN FRANCISCO, CAL.—E. J. WICKSON, *Secy.*

Jan. 12, 1888.—A friendly letter was read from the Microscopical Society of Wellesley College.

Professor H. G. Hanks read a paper on 'Pectolite'—a hydrous silicate of lime and soda. This mineral was discovered in 1828, and described by Von Kobel, who gave it the name signifying 'Combstone,' indicating its peculiar structure. The mineral is rather rare, having been found at but about eight localities, until its recent discovery in California. Pectolite has several varieties, which Professor Hanks described. The first notice of it was given in the 'Fourth Report of the California State Mineralogist.' C. H. Aaron found a single doubtful specimen in a bowlder at the foot of White Mountain in Mono county. In the early part of 1887, a beautiful translucent, nearly white rock was discovered in Tehama county, which was pronounced pectolite by Prof. W. P. Blake.

The specimen was recently received from George Senn, who brought it from Santa Barbara under the impression that it was asbestos. It was found in a mining claim owned by John C. Keyes, where it occurs in large quantities and could be taken out by the ton. The microscopic character of the material was noticed. When handling it considerable annoyance was experienced from the prickly nature of the minute spicules or acicular fibres that enter the flesh like nettles. Being very sharp and small, they can only with difficulty be extracted. The microscope showed why this effect was produced. Each slender crystal breaks in a direction oblique to its sides, and this peculiarity of cleavage produces the keen-pointed needles that so easily penetrate the flesh and skin.

Dr. Fredericks, of New York, gave an account of his mineralogical studies in Southern California. He reported finding kyanite at Carga Muchacho gold mines in San Diego county, near Fort Yuma. He remarked the resemblance between the occurrence of minerals at this location to that of Manhattan Island.

Dr. Douglass Montgomery gave a lecture on the nature of cancerous growth, illustrating his remarks with blackboard drawings and microscopic preparations. He pointed to the layers in which the malignant growth originates, traced its course, and pictured its effects.

J. G. Clark exhibited a slide of the Edge Hill diatomaceous material donated by William Irelan of the Mining Bureau. The earth was seen to contain only the commoner forms.

A very interesting object was a slide of marine polyzoa, containing small corals. It was mounted by F. L. Howard out of materials received from Australia.

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WASHINGTON, D. C.—E. A. BALLOCH, *Secy.*

Dec. 27, 1887.—The 70th meeting. An exhibition of preparations and an informal discussion of methods of mounting was had. Prof. Seaman described a plan of showing multiple images in the eyes of insects as follows:—Upon a piece of card-board, large enough to cover the mirror, make a cross with black ink, each of the four arms of which may be about half an inch long by one quarter inch broad. Clamp this paper over the upper surface of the mirrror and reflect the light from the paper to the lower surface of the slide, containing the preparation of the insect's eye. It is, in fact, simply a substitution of the card-board for the mirror.

Prof. Seaman showed an ingenious device for cementing the Pierce cells to the glass slips. In response to an inquiry for a good shellac cement he gave a formula from which he had secured the best results. (See page 53).

Dr. J. M. Lamb showed slides of tissues from the *Amphimua*, noted for the exaggerated size of all its histological elements. Double stainings of the blood corpuscles of this amphibian were particularly interesting.

Mr. Chapman said that he had been trying to mount some of the mosses sent out in the 'Ward' packets, but had met with considerable trouble owing to the difficulty of getting rid of the air contained in the specimens. As a last resort he had boiled them, dehydrated with alcohol, passed through oil of cloves, and then mounted in balsam.

This society will hold its annual soirée in April next.

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ESSEX COUNTY, N. J.—F. VANDERPOEL, *Secy.*

Dec. 15, '87.—At the meeting held at the residence of Mr. Geo. S. Woolman, Orange, N. J., Dr. Allan exhibited some slides illustrating *caries* in teeth, both natural and ar-

tificially produced (caries); the latter by Dr. Miller, of Berlin, Germany. He also exhibited an 'apochromatic' objective ($\frac{1}{12}''$), of Powell & Lealand's make, and the test upon the Podma scale was exceedingly satisfactory. The lens, however, was not thoroughly tested. Rev. Fred'k Carter interested the society with an exhibit of some eight or nine different members of the Rhizopoda family, including two varieties of *Difflugia*, two of *Nebela*, a *Quadrula symmetrica*, together with *Assulina seminulum*, *Arcella vulgaris*, *Euglypha ciliata*, and *Placocista spinosa*.

Following these exhibits there was a little fine work done by some of the members. Mr. J. L. Smith resolved the transverse markings of the *Amphipleura pellucida* into DOTS, using a Bausch & Lomb hom. imm. objective of $\frac{1}{8}$ inch with his own medium, having a high index of refraction. The illumination was by means of a Wenham reflex illuminator. The members of the society were unanimous in their decision that the feat was accomplished.

Mr. Woolmam resolved *A. pellucida* into *lines* with a Spencer hom. imm. $\frac{1}{10}''$ and mirror illumination.

Mr. Carter also resolved the *A. pellucida* into *dots*, using Smith's stand (a fine Powell & Lealand) and his own lens, which was a companion lens of Mr. Smith's.

January 5, 1888.—Meeting at residence of Dr. Morgan W. Ayres, at Upper Montclair. The Society listened to a paper by Dr. Ayres, upon 'The Structure and Function of the Mammary Gland.'*

Oil-color charts had been carefully prepared to illustrate the subject. The first chart represented the framework of the chest, showing the ribs in position, and the location of the nipple at the upper border of the fifth rib.

The second chart showed a section of the mammary gland, composed, as it is, of fibrous and connective tissue.

The anatomy of the lobules was next fully explained and enlarged acini in different stages shown.

He gave lantern views of negatives made from lithograph plates which were drawn under the direction of Sir Astley Cooper in 1845 from actual dissection.

The first slide represented the mammary glands of the porpoise. A section of a full gland was shown (enlarged), injected with mercury, the ends of the lacteal ducts being tied. The next two slides were illustrative of the glands of the bitch and cow, respectively. In the latter an immense amount of surface was seen to be given over to the receptacle for the milk.

A slide represented the human mammary gland with the follicles somewhat enlarged. In this slide the nipple was shown as being supplied with different orifices through which the milk is brought to the surface. Other slides showed the mammary gland in the fœtal condition and blood-vessels surrounding each of the acini.

Following these were a number of microscopic slides showing glandular structure and mucous glands in the nipple of a rabbit. They were stained with hæmatoxylin-eosin. There were cross-sections of the same showing fibrous septæ between the lobules. Others were as follows:—

True cell structure or secreting portion of a gland; each of the acini being surrounded by its own fibrous net-work, making it separate and distinct.

Quiescent stage of human breast before pregnancy. Secreting portion of the gland is almost obliterated, and there is a great proliferation of connective tissue with acini closely packed.

Intermediate stage. Acini becoming much enlarged.

Full activity of the gland brought into play. The fibrous tissue reduced to a minimum.

Septic mammitis; 9th month of pregnancy. Glands filled up with inflammatory matter. Colostrum cells colored black with osmic acid.

Following the exhibition of the slides with the lantern, Dr. Ayres showed a number under the tube.

Dr. Chambers also brought a diagram representing a sarconatous growth removed from a breast in which, although the excision had been made larger than ordinarily in cases of this kind, it did not in this case guarantee an entire removal of the cause, nor a non-recurrence of the trouble, as the fibrous prolongation of the growth was shown by the microscope to extend down into the flesh beyond the incision made by the knife.

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*See page 51.

NOTICES OF BOOKS.

The Twelve Tissue Remedies of Schüssler. By William Boericke, M. D., and W. A. Dewey, M. D. 303 pp., 8vo : Phila. Hahnemann Publishing House.

In addition to all that Schüssler wrote is presented a large accumulation of homœopathic experience. The book is for the profession, which is exhorted to prove these remedies and to confirm Schüssler's methods.

These 12 remedies are Phosphate of Lime, Fluoride of Lime, Gypsum, Phosphate of Iron, Chloride of Potassium, Phosphate of Potash, Sulphate of Potash, Phosphate of Magnesia, Chloride of Sodium, Phosphate of Soda, Sulphate of Soda, Silicic Oxide.

Chapter I contains a general treatment of the subject, its history, theory, &c. Chapter II describes each of the 12 remedies. Chapter III describes the treatment for each disease. Chapter IV is a magnificent repertory of symptoms and the treatment for each.

The index is not very good. The typography and mechanical execution reflect very great credit upon Mr. F. E. Boericke, the publisher. We congratulate these San Francisco doctors upon their valuable contribution to homœopathy.

A Popular Mineralogy and Geology. By Katherine E. Hogan. 69 pp., 12mo. A. Lovell & Co. New York.

This little volume, which is illustrated with a dozen plates, and made up of very short chapters, was evidently intended for children. The cuts are not expensive, the typography and binding are economical, and, hence, the cost is so moderate that no financial objection can be raised against the book. Its opening sentence, 'In the beginning God created the heavens and the earth,' &c., will, perhaps, indicate its religious character. Its mineralogy is limited chiefly to 4 pages on 'the metals,' and to about 3 pages on rocks. The words geology and mineralogy were doubtless used not to put forth the claim to distinction as such, but for lack of a better title with which to cover a collection of easily understood facts about the planet we live on.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, an material for mounting.]

WANTED.—Parasites and books on Parasites and other micro. subjects. Will give Anatomical, Pathological, Botanical, Micro-fungi, Zoophytes, Polycistinæ, Foraminifera, Parasites, and other slides in return.
FRED. LEE CARTER, Gosforth, near Newcastle-on-Tyne, England.

Wanted, Diatomaceous earth from Mégillanes, Bolivia, South America. Can give in exchange either Diatomaceous earth from New Zealand or cash. E. MICHALEK,
I. Fleischemarkt, No. 1, Vienna, Austria.

Mounted sections of Fœtal Lung (5 months), sections across entire lobe, $\frac{1}{250}$ in. thick, beautifully stained, in exchange for first-class pathological slides. W. C. BORDEN, M. D., U. S. A.,
Fort Douglas, Utah.

Correspondence relative to exchange in microscopical material or prepared mounts.
HENRY L. OSBORN, Hamline, Minn.

Wanted, earths, recent diatoms, and miscellaneous objects for mounting. Only first-class material offered or desired. MARY A. BOOTH, Longmeadow, Mass.

Fossil Diatomaceous deposits (marine) wanted from Bermuda, Virginia, Maryland, California, etc.
I. ELLIOTT, Ardwyn Villa, Aberystwith, Wales, England.

Labels for slides. EUGENE PINCKNEY, Dixon, Ill.

Notices.—All communications for publication should be addressed to Henry Leslie Osborn, Hamline University, Hamline, Minn.

Subscriptions, and all matters of business, should be addressed to the Manager, Chas. W. Smiley, P. O. Box 630, Washington, D. C.

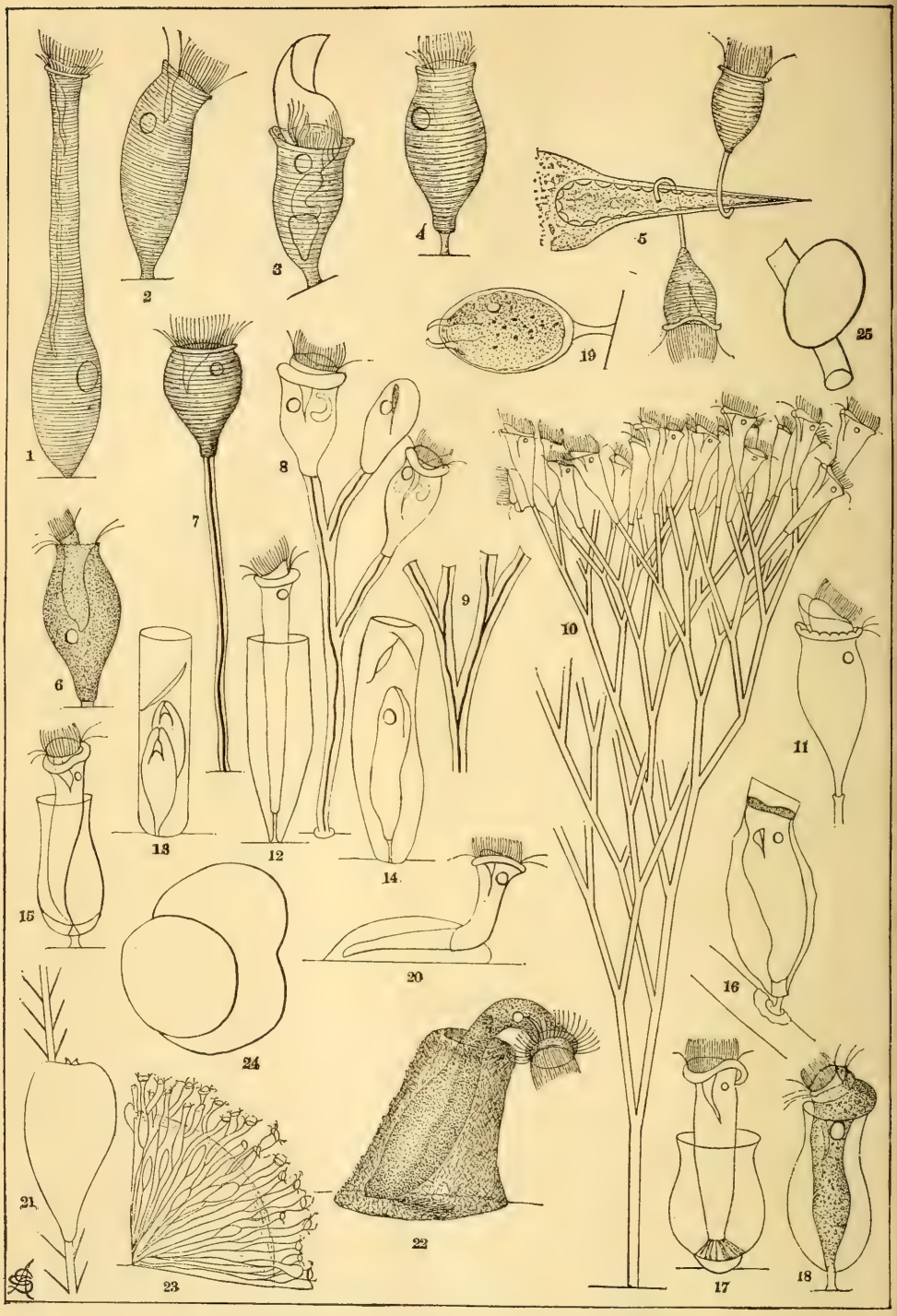
Subscription price $1.00 PER YEAR *strictly in advance. All subscriptions should end with the December number.* A pink wrapper indicates that the subscription has expired. A date on the wrapper indicates the month to which payment has been made.

Orders for slides advertised by A. J. Doherty in the Journals from January to April, 1887, may be sent through the Business Manager, P. O. Box 630, Washington, D. C.

A few copies of Leidy's Fresh-Water Rhizopods, of North America, can still be had at $5.00 per copy.—P. O. Box 630, Washington, D. C.

Remittances should be made by postal notes, money orders, or by money sent in registered letters. Drafts should be made payable in Washington, New York, Boston, or Philadelphia, to the order of the Manager.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the following prices which are net:—Vol. II (1881) complete, $1.50; Vol. III (1882), out of print; Vol. IV (1883) complete, $1.50; Vol. V (1884) complete, $1.50; Vol. V (1884), Nos. 2–12, $1.00; Vol. VI (1885), $1.50; Vol. VII (1886), $1.00; Vol. VIII (1887), $1.00. As calls for Volume I sometimes occur, those persons having copies to dispose of would do well to inform us, and to state their prices.



SEDENTARY FRESH-WATER PERITRICHA.

THE AMERICAN

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A generic synopsis of the sedentary fresh-water Peritricha.

AN ELEMENTARY CHAPTER FOR BEGINNERS.

BY DR. ALFRED C. STOKES,

TRENTON, N J.

Stein, the eminent German investigator of the infusoria, has classified the ciliated animalcules into four orders, thereby making an arrangement of these little creatures which is so natural and so satisfactory that it will probably always remain the accepted method of grouping them. This system, which depends upon the character and the mode of distribution of the cilia that more or less completely clothe the infusorian's body, may be concisely presented in tabulated form as follows:—

I. Cilia clothing the entire surface, and differing but slightly or not at all in size . . . . . HOLOTRICHA.

II. Cilia clothing the entire surface, but those about the oral aperture (mouth) noticeably larger . . . . . HETEROTRICHA.

III. Cilia limited to one or more wreaths around the anterior or posterior extremities, or both, the rest of the body-surface entirely naked, or with an equatorial locomotive circlet . . . . . PERITRICHA.

IV. Cilia confined to the anterior border, and the lower (ventral) surface; upper (dorsal) aspect naked; body usually flattened, HYPOTRICHA.

The members of these orders are among the most abundant of the infusoria. In vegetable and animal infusions they swarm in countless thousands. In the summer pool, the ditch, the mill-pond or the shallow lake, they are, as a rule, more frequently met with than are those animalcules which have been grouped together under the Flagellata of Ehrenberg, or the Tentaculifera of Huxley (the Acinetaria of Lankester). They are also the largest, some being distinctly visible to the unassisted eye of the trained observer,

EXPLANATION OF THE PLATE.

FIG. 1.—Gerda vernalis.
2.—Scyphidia constricta.
3.—Spirochona tintinnabulum (after Kent).
4.—Rhabdostyla vernalis.
5.—Opisthostyla pusilla.
6.—Pyxidium urceolatum.
7.—Vorticella aquæ-dulcis.
8.—Carchesium epistylidis (after Kent from C. & L.)
9.—Zoothamnium. Pedicle showing continuous muscular thread.
10.—Epistylis vaginula. A portion of a large colony.
11.—Opercularia plicatilis. Single zooid showing membrane beneath the ciliary disc.
12.—Vaginicola leptosoma.
13.—Thuricola valvata. Valve closed on the contracted zooids (after Kent).
FIG. 14.—Thuricolopsis innixa. Zooid contracted; valve closed.
15.—Cothurnia imberbis (after Kent).
16.—Pyxicola constricta. Showing operculum; zooid contracted.
17.—Stylocola striata (from Kent after De From.)
18.—Pachytrocha cothurnoides. Showing fleshy operculum (after Kent).
19.—Stylohedra lenticula (after Kellicott).
20.—Platycola decumbens (after Kent).
21.—Lagenophrys obovata. An empty lorica on a bristle of an Entomostracan.
22.—Ophionella picta (after Kent).
23.—Ophrydium. A small portion of a colony enlarged (after Kent).
24 and 25.—Ophrydium. Colonies, natural size (from Kent after Ehrenberg).

both as single individuals and as those populous aquatic clouds which they so often produce. In connection with this profusion, the writer has recently seen the common *Paramæcium aurelia* (one of the Holotricha) so profusely developed in a vegetable infusion that they formed, next the side of the glass vessel, a whitish mist fully one-tenth inch in depth, and extending one-third the distance across the jar six inches in diameter, and for about the same distance around it.

The present paper deals, in an elementary way, with but one family group in one of the above orders, the Vorticellidæ in the Peritricha, none of which, when mature, are free-swimming forms. At one stage of their life, however, they all, so far as known, pass through a migratory phase, settling down sooner or later to become permanently sedentary at the selected point of attachment. We shall here deal with the mature forms alone, further limiting our attention to those whose habitat is in fresh water, or in animal or vegetable infusions made with fresh water in contradistinction to salt. The object of the paper is to call attention to the interesting forms of sedentary Peritricha so often met with by the amateur microscopist, especially in early spring, and often passed by with a hasty glance, and a feeling of regret that so little can be learned of them from the books within reach. The mere learning of the name is a help towards further self-instruction, if the learner cares to follow up the clue thus obtained. Space forbids an entrance into the dètails of microscopic anatomy, or even into extensive description; only the most concise diagnoses of the genera can now be given. This particular family group has been selected on account of the grace and the indescribable charm of its members, and by reason, as well, of their abundance and the frequency with which the student of microscopical pond-life will meet them.

The Peritricha includes ciliated infusoria whose vibratile appendages are borne on one or both extremities of the body; but the family here referred to includes only those whose ciliary circles are confined to the anterior region. There may be a single ciliary wreath extending around the edge of the frontal border, approaching in a more or less spiral course the somewhat eccentric mouth; the wreath may be more nearly circular, or it may be supplemented by from two to six additional ciliary circles. The central space bounded by the cilia may occupy the entire frontal surface of the body, as in the common *Vorticella;* it may be a level or an oblique plane, or a more or less strongly convex dome. In any case the region bounded by these vibratile hairs is known by the very appropriate name of the ciliary disc, an organ that is somewhat diverse in character and appearance. In some genera this ciliary disc is not more lofty than the anterior body-margin; in others it is conspicuously elevated on a narrow, supporting neck, while its frontal surface may be so strongly turned away from the central axis of the body that it becomes one-sided. In other genera (*Spirochona* and *Opercularia*) it is accompanied by, or it even bears, a colorless transparent membrane, in appearance like a hyaline collar, the object of which is to assist in directing the food into the proper channel.

The movements of the cilia are so rapid that they are visible only by their effects, or only at those points where two circles seem to meet and pass each other, the appearance then being that of a fine, motionless bristle, an optical illusion sometimes leading the inexperienced observer to imagine that the infusorian has its cilia represented by two setæ. These energetic movements subserve one purpose only—the collection of food particles from the swirling eddies produced by their action, and the directing of those particles into the waiting oral aperture, whence they enter through a distinctly developed pharyngeal passage into the substance (endoplasm) of the body, accompanied

and surrounded by a drop of water. This passage is, as a rule, conspicuously visible only while the food-globule is traversing it, although, in some forms, its walls are ciliated. Careful examination, however, will usually disclose at least some portion of it. The anal aperture opens into the pharyngeal passage, the excrementitious substances being swept out by a sudden and momentary reversal of the ciliary currents.

The water drop entering the endoplasm with each food-globule must, in some way, be disposed of, otherwise, since the animalcules are voracious and almost insatiable, the body would soon become a mere film enclosing a quantity of water. To dispose of this accumulating liquid a contractile vesicle has been developed. This is commonly conspicuous in all the family as a more or less spherical, pale pinkish vacuole, which disappears and slowly returns to its former position at regular intervals. Its contents are supposed to be those water drops which enter the endoplasm with the food, and to be collected by means of minute channels which are believed to ramify throughout the entire body, transmitting their liquid to this contractile reservoir, whence it is expelled either into the pharyngeal passage or directly into the external water. These drainage canals have not been positively seen; if they exist, as they probably do, they must be excessively minute, and their walls are probably not lined with a distinct membrane, but consist simply of passages in the soft endoplasm without differentiated boundaries. They may, therefore, be not persistent canals, always holding the same position and taking the same course, but they may be developed at any point in any direction where needed within the parenchyma, and at any time. That the contractile vesicle itself has no lining membrane is the generally accepted belief, yet the propulsive power of the soft endoplasm is such that the vesicle contracts with considerable force. In some of the flagellate infusoria where the contractile organ opens directly into the external water, I have seen the outward current carry away, in a comparatively violent puff, contiguous bacteria and minute fungous spores, sweeping a clean path before it. In some of the Peritricha there is more than one contractile vesicle in the same individual.

The entrance and expulsion of the water drops subserve two important functions—those of respiration and excretion. The entering water oxygenates the endoplasm as it circulates, and at the same time carries off any gaseous or other absorbable excrementitious materials, bearing the noxious substances to the pulsating vesicle where the vitiated liquid is expelled.

A second important internal organ is the nucleus. This is usually seen, and without much trouble, as a granular body with refractive properties differing from those of the endoplasm surrounding it. In the Vorticellidæ it may take the form of an ovate or subspherical nodule, or of a flattened and variously curved, band-like body. It plays an important part in the act of reproduction.

The external surface of those animalcules comprising the Vorticellidæ is generally a somewhat firm cuticular membrane, often adorned by fine transverse striæ or other ornamental markings. In some this cuticular coat is so firm that it retains the shape of the zooid after the latter's death, and the escape, by diffluence, of the endoplasm.

The Vorticellidæ are all timid creatures; a sudden jarring of the table, or a gentle tap against the microscope, or even the unexpected contact of some floating object being sufficient to throw the majority into a spasm of contraction, the ciliary wreaths being quickly folded together and depressed across the ciliary disc, the body drawing itself into as small a compass as possible and crouching against the supporting object, while the entire frontal region is rounded and closed, so that no vestige of the ciliary apparatus is visible. The loricate and illoricate forms are equally timid, the animalcules within the

protective sheath being equally as ready as its unprotected relative to fold together its vibratile appendages and to leap backward into the rearmost region of the lorica, whence it slowly extends itself when all danger is past, and as slowly and cautiously expands the body and sets in motion the ciliary circles. The type of the family is the common *Vorticella*, an infusorian so well known, both in connection with its appearance and the nervous coiling of its pedicle or foot-stalk, that no further reference to it is here needed.

In addition to the separation of the members of the family into free-swimming and sedentary forms, and the further division of the permanently attached zooids into loricate and illoricate groups, the unprotected sedentary animalcules are still further subdivided into two sections, according as they are sessile or lifted upon a pedicle, while the pedicle may be either rigid or contractile, simple or compound. Thus by a very natural method of classification the Vorticellidæ are readily identified even by the beginner, and he is then prepared for further study of their structure.

In *Vorticella*, the typical genus of the family, there exists, immediately beneath the cuticular surface, an extremely thin and delicate but highly contractile layer surrounding the body as with a muscular sheet or investment, and continued through the pedicle or foot-stalk as a stout and usually conspicuous muscular thread, whose contractions are the cause of the very sudden backward leaping of the animalcule when under observation. This muscular sheath of the body is extremely delicate, being apparent only under strong amplification and after careful scrutiny. Its contractions, however, are the cause of the body's unexpected assumption of the subglobular form, which sometimes follows the coiling of the pedicle after a short but appreciable interval. The muscular thread of the pedicle in *Vorticella*, *Carchesium*, and *Zoothamnium* is a long spiral within an external hyaline sheath, the latter seeming to take no more active part in the muscular movements than the human skin takes in the movements of the finger or other muscles. This sheath appears to be elastic only, occasionally scarcely that, and to be continuous with the external cuticular coat of the body. The muscular thread varies somewhat in character in the various species of *Vorticella*, often enclosing small, granular particles, especially noticeable near the edges, while in some species it exhibits larger crimson or bright green corpuscles.

The pedicle of *Vorticella* is always unbranched, and normally bears but a single body. When two *Vorticellæ* are observed on the summit of the same pedicle one is there temporarily only, being the result of longitudinal reproductive fission. It will soon be seen to develop a posterior circle of cilia, which, by their rapid vibration, speedily twist the body free, hurrying it away to seek a pleasant spot for the erection of a pedicle and a repetition of the act of fission. When *Vorticella* is in uncomfortable surroundings it will often develop this posterior ciliary wreath and leave the pedicle to skurry away for more congenial quarters. If watched it will be seen to skim over many apparently pleasing surfaces, with the ciliated extremity downward, and, having selected a favorable location, the secretion of a new pedicle is begun, the posterior cilia are absorbed, the frontal region is expanded, and the anterior cilia are again spread and put into vibration. This ability to twist free from the foot-stalk at will is one of the characteristics of all the pedicellate Vorticellidæ.

There are genera in the family whose pedicle, unlike that of *Vorticella*, is compound and dendroid, its branches spreading at the summit of the common trunk, while the living animalcules are stationed singly or in groups on the ends. In some of these colonial Vorticellidæ the entire tree-like pedicle is rigid, the soft bodies alone contracting (*Epistylis*); in others the main stem, the branches, and the bodies all contract together (*Zoothamnium*); in

others the primary trunk and the limbs may contract independently, although in these colonies the movement of the main stem is usually followed by the contraction of one or more of the branches with the attached bodies (*Carchesium*); in still another the pedicle is rigid, but the lowermost portion is curved around the object to which it is attached, and acts as a spring to suddenly sweep the entire organism circularly through the water and back again to the normal upright position, the curved portion having the function of a spring (*Opisthostyla*).

The methods of reproduction are sufficiently diverse, but in a short paper with the character of the present one they can be only mentioned, leaving details for a future time. In addition to the commonly observed longitudinal division, the methods are by transverse and oblique fission, the encystment of the body, with subsequent subdivision into minute spores, and by the formation of buds which finally become migratory zooids and unite with some mature infusorial body of the same species as their parent, the living combination of animalcule and fertilizing microzooid, at some future time undergoing reproductive fission. In *Vorticella* conjugation of mature forms has occasionally been observed.

The sheathed, or loricate, members of the family, while they do not attract attention by their movements, as does *Vorticella*, or by the beauty of their dendritic pedicles lifting into the surrounding water a wealth of living fruit, yet they are always charming by reason of the graceful contour or the peculiar appendages of the loricæ. Hyaline vases and crystalline amphoræ, with their anterior aperture open to the water, or protected by a movable valve; bodies with no protection except the delicate walls of their loricæ, or bodies with a chitinous or fleshy antero-lateral outgrowth, called the operculum, with which the contracted animalcule plugs up the aperture to its home; all these and others help form the interesting group of the Vorticellidæ.

The loricæ are secreted by the bodies of the enclosed animalcules. The soft and colorless substance forming them has the property of hardening on contact with the water, thus becoming an effectual barrier to danger. When young these sheaths are colorless and transparent as glass; when mature or old they often become chestnut brown in color and sometimes almost opaque.

Others of the loricate section of the family do not produce loricæ in the usual sense of hardened, chitinous enclosures, but protect themselves by the secretion of a soft and jelly-like substance in which they live, and into which they retreat when danger threatens. One of these (*Ophrydium*)—there are but two, the second being *Ophionella*—is not rare in ponds and still waters where the colonies may be found in the form of little green jelly masses adherent to aquatic plants, or floating on the surface as rounded globules, varying in size from that of a pea to that of a walnut; indeed, immense colonies the size of one's fist have been recorded, but these are uncommon. *Ophionella* is a solitary creature, erecting its soft sheath on some water-weed away from all of its own species, and never forming social colonies. It is rare in this country, having been observed but once, so far as I am aware. Prof. D. S. Kellicott, of Buffalo, has had the good fortune to find the curious animal in the Niagara river.

We have thus superficially noted some points in this infusorial family in order, as has been said, to lead the beginner in the study of microscopical pond-life to an easy, and it is hoped, satisfactory identification of the genera comprising the family. To include the species is not practicable in the limited space of a single paper.

The following key is to be used as all similar analytical tables are used. A good half-inch objective is probably sufficient for the purposes of identification; a quarter-inch will be amply sufficient.

ANALYTICAL KEY TO THE SEDENTARY GENERA OF THE FRESH-WATER PERITRICHA.

A. Animalcules free-swimming; ciliary system an anterior wreath, with or without a postero-terminal circle, and occasionally an equatorial girdle of locomotive appendages. (Omitted for the present.)
A. Animalcules permanently attached; ciliary system one or more anterior wreaths of vibratile appendages; inhabiting fresh water (B).
B. Animalcules illoricate (without protective sheath) (§).
B. Animalcules loricate (with protective sheath) (§§).
B. Animalcules immersed within a gelatinous investment (§§§).
§ Animalcules sessile (*a*).
§ Animalcules with a pedicle (*c*).
§§ Lorica erect (*j*).
§§ Lorica decumbent; adherent by the flattened side (*o*).
§§§ Gelatinous sheaths solitary . . . . . *Ophionella*, S. K. (Fig 22).
§§§ Gelatinous sheaths forming adherent or freely floating masses often visible to the naked eye . . . . . *Ophrydium*, Ehr. (Figs. 23–25).
a. Anterior border bearing cilia only (*b*).
a. Anterior border bearing a hyaline, membranous funnel, *Spirochona*, Stein (Fig. 3).
b. Body posteriorly attached by a sucker-shaped cup . *Scyphidia*, Duj. (Fig. 2).
b. Body posteriorly attached without a sucker-shaped cup, *Gerda*, C. & L. (Fig. 1).
c. Pedicle without a contractile, muscular thread (*d*).
c. Pedicle with a muscular thread (*f*).
d. Pedicle simple (not branching) (*e*).
d. Pedicle compound (branching) (*i*).
e. Pedicle always motionless, usually shorter than the body; ciliary disc not one-sided, *Rhabdostyla*, S. K. (Fig. 4).
e. Pedicle motionless, short; ciliary disc one-sided, . *Pyxidium*, S. K. (Fig. 6).
e. Pedicle springing backward when the zooid contracts, curved below, usually well developed, ... *Opisthostyla*, Stokes (Fig. 5).
f. Pedicle simple (not branching) (*g*).
f. Pedicle compound (branching) (*h*).
g. Zooids attached singly to the highly contractile pedicle, *Vorticella*, L. (Fig. 7).
h. Muscular thread interrupted at each bifurcation of the pedicle, *Carchesium*, Ehr. (Fig. 8).
h. Muscular thread continuous through the main stem and the branches, *Zoothamnium*, Ehr. (Fig. 9).
i. Ciliary disc not one-sided, without a collar-like membrane, *Epistylis*, Ehr. (Fig. 10).
i. Ciliary disc one-sided; a small collar-like membrane below and to one side of the disc, ... *Operculariа*, Stein (Fig. 11).
j. Lorica sessile (*k*).
j. Lorica with a pedicle (*l*).
k. Lorica with a movable, oblique valve, and an opposite bristle-like valve-rest below the aperture within, ... *Thuricolopsis*, Stokes (Fig. 14).
k. Lorica with an internal valve but no valve-rest, . *Thuricola*, S. K. (Fig. 13).
k. Lorica with neither valve nor valve-rest (*n*).
l. With an antero-lateral, horny operculum, . . *Pyxicola*, S. K. (Fig. 16).
l. With an antero-lateral, soft, fleshy operculum, *Pachytrocha*, S. K. (Fig. 18).
l. Without an operculum (*m*).
m. Aperture of lorica permanently open when the zooid is contracted, *Cothurnia*, Ehr. (Fig. 15).
m. Aperture of lorica closed (valvular) when the zooid is contracted, *Stylohedra*, Kellicott (Fig. 19).
n. Zooid posteriorly attached to the lorica by numerous radiating processes, *Stylocola*, From. (Fig. 17).
n. Zooid posteriorly attached to the lorica directly, or by means of a short pedicle, *Vaginicola*, Lam. (Fig. 12).

Elementary histological studies of the Cray-fish.—IX.

By HENRY L. OSBORN.

CHAPTER III.—THE INTESTINE.—(*Continued from page 25.*)

4. **Histology.**—The beginner will be mistaken if, on first look at the section, he expects to find each cell of the various tissues standing out for easy recognition. He must very carefully observe the caution we have already recommended in connection with these studies. The cells are so thin-walled that they are pressed into somewhat irregular shapes, and the thin walls often baffle all our attempts to see them. But if he will apply the principle I before insisted on, of picking out the repeated parts and observing them closely, he will find his way through. I am convinced that the faithful study of the sections. with intelligence guided by some such principle, will help any beginner to an insight into the real construction of the tissues of his section, and that, without it, while he may be taught, by rote, which is any particular kind of cell, he will never reach a place where he can, without a guide, study with well-founded confidence.

The intestine is, in one sense, a much simpler organ than the liver, the subject of the last study, for it consists of only one hollow tube of a certain length and diameter, while the liver is formed of a very large number of blind pouches, which are connected with each other and with their ducts in a manner not, at first sight, entirely plain. and only so after considerable study. The *anatomy* of the intestine is far simpler than that of the liver; but the *histology* of the intestine is much more complex than that of any organ thus far reached in the course of these studies. I have already pointed out the existence of several tissues, the mucous membrane, circular muscle layer, longitudinal muscle layer, and the sub-mucous layer. Nothing similar to these muscular coats can be found in the green gland or in the liver. I shall, later, take occasion to point out that the mucous membrane is similar in all three. In studying more closely than we have already done, it will be convenient to follow the order already followed in their coarser recognition.

1. **The mucous membrane** must be studied with a power of 250 diam. If the section be a good one, both well-preserved and cut thin, the membrane will appear to be a broad tinted band with a 'hyaline' or transparent zone at one side next the cavity of the intestine and with a thin, sharp line bounding the band on the other side, at some places, but entirely disappearing in many others. This broad band will be found to be by no means of even tint, but near the hyaline border in many places will be seen innumerable minute, very dark specks which do not extend entirely across the band, and at about the same distance from the border of the band a row of oval bodies, the nuclei of the cells. By further careful study faint lines may be seen crossing the band somewhat as shown in figures 2 and 4. After the discovery of these cross-lines, by sufficient study the observer can convince himself that the cross-lines bear a certain relation in position to the position of the nuclei, falling one on each side of them, as shown in the very highly magnified camera-lucida drawing, figure 3. These features, though perhaps nowhere readily seen, will in many places be indistinctly seen, and often definitely enough to leave no doubt as to the correctness of the interpretation. The broad band is a corrugated sheet—it is a sheet of substance granular and deeply stained; scattered through it, at approximately the same level, are bodies, oval in outline, more intensely stained than the granular substance of the sheet. The oval bodies are never at the upper part of the sheet or the part next the cavity of the intestine. The sheet, further, the lining of intes-

tine, is constructed out of columnar cells (only positively proven by sections in at least two directions), whose nuclei, the oval bodies, are placed deeply in the cell near the basement membrane. Perhaps a lucky section may demonstrate one of these cells clearly with its basement walls, side walls, and nucleus even more clearly than as shown in fig. 3, but if it does not do so the sufficient study of the appearances of the section will convince the observer that the interpretation above given is the only one which will explain the actually observed facts. The cells themselves, then, are the granular stained substance which is protoplasm; the active working material with the nucleus, also concerned in the activities of the mucous membrane and the walls, and the work of the mucous membrane of the intestine, is actually parcelled out to the different individual cells.

One very noticeable feature of the cells of the mucous membrane in the intestine is the innumerable small intensely black 'specks' seen in the outer ends of the cells everywhere, so constantly that the irresistible first impression would be that they were a part of the cell as properly as any of the other recognized parts. They are not, however, a necessary part of the cell, for it could doubtless perform its work as well in their absence. Their presence interests the general biologist very much, for they are solid bodies, and have been swallowed by the cells from the contents of the intestine, though usually the food must be made liquid before it can pass into the cells of the intestine and through them to the blood.

Over the mucous membrane of the intestine, throughout its entire length, a thin unstaining hyaline (glassy) band extends, figs. 1, 2, 3, 4, *c*, called the cuticle. The cuticle follows all the bends of the epithelium or mucous membrane, and during life adheres to the outer ends of the cells. In sections, as, for instance, in fig. 3, it may be detached and lie at a distance from the cells. The most careful study of the cuticle fails to show in it a repetition of the facts which prove the mucous membrane cellular, and we may state that it is made by the solidification of a sort of slimy secretion poured out from the mucous cells, hardening where it is poured out, instead of being removed as fast as formed, as are other secretions. It would be interesting again, in a paper of biological interest, to stop for the inquiry into the purpose of this cuticle, but we must set that question aside.

2. **The circular muscle layer** is much more difficult to study and understand than the mucous membrane. First examination of cross sections will show, bounding the entire section, as in figure 1, a narrow band faintly stained and with a few deeply stained oval nuclei scattered at intervals through it. These give some clue to the cells, because the nuclei are in the middle of the cells of the layer. Prolonged examination of good sections will convince one that the circular nuclei layer is penetrated by lines which run with the band. These are faintly shown in the figure of our plate, but only very imperfectly. In sections they will be seen as the walls of the cells, and the cell shape determined to be that of a spindle, long and tapering at each extremity. Further, the cells are placed side by side, and with their long dimension across the intestine cross-section of the cells, which are, you will see, longitudinal sections of the intestine, present the circular layer with a very different look. They are not now seen as long, tapering bodies, but as a row of deeply stained nuclei in a band of faintly stained dots. This is because the narrow, tapering cells, cut endwise, are reduced to scarcely more than points of usually less size than the nuclei because of the taper, a few only being cut through their middle, and because the protoplasm through the cell at large stains less deeply than the protoplasm of the nucleus. The circular muscular layer is composed of cells, which are like the cells in the two layers in the intestines of vertebrates, and known there as unstriped or involuntary muscle.

3. **The longitudinal muscular layer** must be studied chiefly from a longitudinal section; a bit from such a section has been represented in figure 4. It is seen to be made of bands or bundles of protoplasm, granular-stained material, bearing, scattered through the bundles, oval nuclei. The sides of the bundles are often parallel for a distance, sometimes terminating in a triangle. The bundles, also, sometimes break away from the principal mass of this kind of tissue and extend into the submucous space, retaining, however, the characters just noted. The bands exhibit one peculiarity very conspicuous though not as yet mentioned. They are crossed by transverse marks which seem something like ripples on the surface of water. These transverse marks will defy the observer equipped with only the $\frac{1}{6}$-in. objective, and the section prepared as above to explain them, and they have puzzled, and are still puzzling, the biologists. Upon the ends of some of the bundles the protoplasm does not stop short, but is, as it were, 'frayed out,' and in some of the bundles it can be seen that, besides the transverse 'striæ,' the protoplasm is also arranged in longitudinal 'fibrillæ.' This longitudinal and transverse striping of the substance of the muscle tissue is found in so many places and so very plainly that there can be no room for doubt that it is characteristic of the entire longitudinal layer.

The striped substance is not all that can be found in the longitudinal layer. Fine lines, which run parallel with the markings in the protoplasm and which resemble cell walls, are seen bounding the bands; they have received the name of 'sarcolemma,' and they are parts of a membrane which encloses the active or protoplasmic part of muscle. Besides, there are frequent nuclei which careful study will show to be always close to the sarcolemma.

These appearances, if carefully put together, appear to indicate that the muscle layers of the sort we are now examining is composed of bodies whose protoplasm has been considerably changed, at least as regards arrangement in the cell, from the protoplasm in gland cells; for instance, those of the mucous membrane, or even the circular muscle cell. It has, in fact, been disposed in bands, both lengthways and crossways, in a manner which has received very much study. It would be too lengthy for our present purpose to consider this arrangement, or the cause of the 'striæ;' those who would follow the matter further will find it well treated in Huxley's 'The Cray-fish.' The cellular structure of the muscle tissue is obscured by the change which took place during the development of the muscle, but the facts seem to be, briefly, that the cells are very long, and set end to end their end walls obliterated, and their side walls modified to form the sarcolemma. In short, the longitudinal muscles of the cray-fish intestine are unlike the cells of the circular muscle layer, being cylinders placed end to end in parallel rows, their side walls, the sarcolemma, encloses protoplasm so symmetrically arranged inside the cell as to give an appearance of longitudinal and cross striping. It is scarcely necessary to add that the crosscuts of the intestine will cut the cylinders of the intestine muscle crossways, and they will appear as circles modified in shape from contact with other circles.

4. **The sub-mucous layer** contains, besides the blood which wanders freely through it, bathing both the mucous membrane and the muscular coats, certain cells which serve as padding or packing. They are called *connective tissue* cells, and are figured in fig. 4 at C. T. In the sections these can hardly be clearly understood; they seem as if blood corpuscles, well stained, the nuclei inside a space bounded by very fine lines. In many places one cannot positively determine how to interpret the appearance, but in some places he sees very plainly, somewhat large, nearly empty cells, each with its nucleus. In other places such an interpretation is not consistent with the observed facts, and the sub-mucous layer is crossed and recrossed by fine threads which form a network extending (though not traceable) into and among the

members of the muscular layer. The connective tissues which are present in all the organs of complex histology is a most difficult tissue of which to study the cellular structure, and we can very properly set it aside, for the present, to examine it in a place where it can be studied more favorably than in the present situation.

5. **The muscles of the mucous lining** will detain us but very shortly. They will be found, by examination of the mucous lining, scattered through the sub-mucous layer in no very definite pattern, except that they seemingly pull the mucous lining this way or that. They are shown in both fig. 2 and fig. 4, and are of the same histological structure as the inner muscle coat, namely, transversely and longitudinally striped bands. They further seem, in some places, to run into and join the bundles of the longitudinal layer.

Summary.—We have now reached a position where we can see how the statement as to the greater histological complexity of the intestine, as compared with the liver, is true. Examination of the liver, and thoughtful consideration of its mode of composition, shows it to be made by the repetition of one kind of cell, varying in shape, but of one kind. If the intestine be thought on, it is found to be constructed by the repetition of four kinds of cells, all very different, viz., epithelium cells, striped muscle cells, unstriped muscle cells, and connective tissue cells. Further reflection will show that the epithelium of the intestine corresponds in position as well as in general in shape with that of the liver, being situated upon a basement membrane which intervenes between the cells and the blood and lining a cavity which opens to the outside of the body. But a section at the proper place would further prove that the epithelium of the liver duct is continuous without a break anywhere with that of the intestine. We, therefore, are justified in regarding the mucous membrane of the intestine as a gland strictly comparable with the liver or the green gland, while the other parts of the intestine are additional to anything present in the other two organs. It is for this reason that the intestine is histologically more complex. The other parts are to cause movements of the glandular part, or to keep the contents of the intestine from standing still, thus bringing all parts of the food in contact with the glandular part.

We may now revise our definition of a tissue as a structure composed of an assemblage of cells similar in structure and use, and we find the mucous membrane a tissue as tried by this definition, and the outer muscular coat a second, and the longitudinal muscular coat a third. If we made a complete enumeration of the tissues which work together for a common purpose in this organ, the intestine, we should include the parts of the nervous tissues. They are present in the intestine, but not visible by our mode of treatment, and will be adjourned for the present.

We have now studied two kinds of tissue, the glandular and the muscular; several others yet remain, the nerves and the special apparatus, end-organs for the special senses, the skin and protective tissues, the connective tissues, and the reproductive tissues. Some or all of these we hope to be able to consider in subsequent chapters.

(*To be continued.*)

EXPLANATION OF PLATE IN FEBRUARY NUMBER.

Fig. 1.—Cross section of intestine magnified x 50 diameters.

Fig. 2.—Section showing mucous membrane with cuticle and mucous muscles and sub-mucous connective tissue cells. Camera lucida magnified x 370 diameters.

Fig. 3.—Semi-diagrammatic camera lucida drawing of mucous membrane highly magnified (Zeiss F) showing cuticle removed from the cells. Magnified x 690 diameters.

Fig. 4.—Longitudinal section of entire intestine wall, showing outer muscle cells endways and inner coat longitudinally. Magnified by 200 diameters.

All outlines drawn with camera lucida.

B. m. Basement membrane.
c. Cuticular part of mucous lining.
C. M. Circular muscle layer.
C. T. Connective tissue cells.
L. m. Longitudinal muscular layer.
L. w. Side wall of mucous epithelium cells.
M. m. Mucous membrane.
M. muc. Muscles of mucous layer.
M. nuc. Muscle nuclei.
S. m. Sub-mucous layer.

Celloidin; its advantages,*

By J. MELVIN LAMB, M. D.,
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The patented article, celloidin, comes into the market in the shape of cakes, rather transparent, and looking like ordinary glue. Another form is in small shavings or chippings. This is made from the purest pyroxylon, by E. Schering, Berlin, is non-explosive, free from precipitates, and costs about 3 m. per cake.

Inasmuch as a cake dissolved will furnish material enough for embedding 100 to 150 average size specimens, it is, considering its many advantages, quite inexpensive.

It has great advantages for embedding many tissues—and for certain organs, for instance, the eye—results may be obtained which cannot be had by various other methods. To cut sections of the eye, an organ composed of tissues of such varying density, it is desirable to have an embedding mass in which the tissues may be kept in a fluid solution, without injury, until thorough saturation is ensured, and which will maintain the various parts of the object in perfect relationship for cutting, and after sectioning.

For this organ, and for tissues that have no connection of parts—tissues that immediately go to pieces, so that it is impossible to distinguish the relationship of parts—this mass offers superior advantages.

The use of celloidin is a cleanly process, nothing further being required in its application than a few stoppered specimen jars and some corks for fixing the embedded objects for cutting. No amount of experience is necessary in its use to insure good results, and it is comparatively rapid in its action.

In other modes, wax and paraffine specimens must be kept in a moulten mass over a water-bath, maintaining the heat at a certain temperature for a length of time, varying from 6 to 12 hours. Should the heat go above a certain degree, the specimens will be most likely ruined, and if, on the other hand, it falls below the required degree, the process must be repeated.

The celloidin solution permeates the tissues thoroughly, fixing the parts in their natural position, does not shrink the tissues, and the process can be discontinued at any time, or delayed any length of time without resulting in harm to the objects.

It is perfectly transparent, and sections so embedded may be stained and mounted with the embedding material, which takes the staining but faintly; and when a specimen is cleared and mounted, the faint tinging on the celloidin does not detract from the appearance of the section, or in any way interfere with its usefulness.

Celloidin solution is made by dissolving the chippings in an equal part of absolute alcohol and ether. To four ounces of the above, add sufficient celloidin to make one solution of a syrupy consistence; the second somewhat thicker. Unless kept thoroughly stoppered with ground glass, the solutions will thicken by evaporation of the solvents. A quantity of the solvent serves at any time to reduce the solutions to the desired fluidity.

Specimens should be brought from absolute alcohol and placed in a mixture of equal parts of ether and absolute alcohol for about 6 to 8 hours, and then may be carried into the thinner solution.

Let most objects remain here for 24 hours; when they are to be removed to the thicker solution, objects can be safely left in either solution for an indefinite length of time, so that for delicate objects in which it is especially desirable to ensure thorough saturation and fixing of the parts in natural relation, they may be left in the solution for some weeks previous to embedding.

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*Read before the Washington Microscopical Society, Jan. 24, 1888.

I find the method of embedding by the use of a coil of paper about the cork troublesome, on account of the formation of air-bubbles. The simplest and most effectual manner to fasten the specimens to corks is as follows:—Soak the cork for a short time in absolute alcohol, then flow over the surface on which you embed a film of thin celloidin, letting it partially harden. Place the object in the position desired for sectioning by the aid of the amount of celloidin that will adhere to it from the vial. Let this stiffen slightly, then add, at intervals of a minute, a few drops of the celloidin (depending, of course, upon the size of the object) by allowing it to flow over the object and about the base of it. Repeat this until a fair amount is covering and supporting the specimen. By this means you have only the required amount of celloidin about the object to support it firmly, and not a large mass to draw the knife through. After a few moments a film sufficiently firm will have formed to hold the object in position. The entire mass is now to be placed in a jar of alcohol of 80% to harden—requiring 24 to 48 hours. If the cork is shallow and broad no weights will be necessary; merely invert the object in the alcohol and the cork will serve to float it and keep it immersed.

The mass is now ready for the microtome, and the blade should be flooded with commercial alcohol. After sections have been obtained the embedded object can be returned to the 80% alcohol, when it can be preserved for future use.

In clearing sections avoid the employment of absolute alcohol (unless used cautiously) or clove oil, as these agents rapidly dissolve the celloidin. Sections so embedded are best cleared in creosote and mounted in xylol balsam.

24th JANUARY, 1888.

On the Use of the Microscope in Petrography.

BY WM. H. HOBBS,

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The brilliant results obtained at the opening of the present century by William Smith, the father of English geology, directed the attention of geologists to an arrangement of the secondary formations in definite horizons, by a study and comparison of their organic remains. The lively interest that was at once aroused, and the promise of important results, produced a most desirable change in geological research. The bitterness and lack of candor, which had been so characteristic of the controversy between the rival schools of Freyberg and Edinburgh on the origin of trap rocks, became matters of less common occurrence and were gradually lost sight of in the newly-opened field of geological inquiry. From the publication of Smith's geological map of England, in 1815, to near the middle of the century, the study of the crystalline rocks, though undertaken by some, received an amount of attention in no degree commensurate with that devoted to the fossiliferous strata. The great controversy of the Neptunists and Vulcanists did not end, however, without yielding some important results. Demarest had shown conclusively that the older rocks of the Auvergne were the product of volcanic action, and Hutton clearly proved in 1785 the igneous origin of the granite of the Grampian Hills. In order to understand the small results that were obtained at this period in the study of the massive rocks, we have only to consider the difficulties which had to be encountered. The coarse-grained rocks allowed a separation of their component minerals which could then be tested as to hardness, specific gravity, color, lustre, cleavage, streak, and, best of all, chemical composition. The new formulation of the law of the constants of the interfacial angles of crystals by Romè de l'Isle and the invention of the goniometer afforded the most ac-

curate method of identification of minerals when they could be obtained in crystals. But with the greater number of occurrences of massive rocks such methods of study were found impracticable, owing to the fineness of the rock-texture. It is, therefore, no matter for surprise that the finely crystalline rocks were supposed to be entirely made up of some one mineral, and were given names having that significance. It was not until 1815 that Cordier showed the complex character of basalt by a separation of its constituents by means of differences in specific gravity.

The early attempts to subject rocks to a microscopical examination were failures, because they only made use of reflected light. Transmitted polarized light was employed by Sir David Brewster in 1816 to study the inclusions in topaz, beryl, and other very transparent minerals. The experiments of Wm. Nicol with petrified wood, fourteen years later, were most important. They embrace the idea which, later, caused the birth and development of microscopic petrography. Nicol made a thin, transparent section of petrified wood by attaching a small fragment to a piece of wood by means of cement. By the use of a grindstone the greater part of the chip was ground away. It was then polished and attached by Canada balsam to a small plate of glass, after which the process of grinding and polishing was applied to the other side, until the chip was thin enough to be transparent. It was then ready to be examined with the microscope. It is, perhaps, a little surprising that the importance of this method was not at once appreciated and applied to the study of rocks, inasmuch as the experiments of Nicol were made in the related science of palaeobotany.

It was not until twenty years later (1850), however, that the application was made, when H. Clifton Sorby, of Sheffield, England, examined a specimen of calcareous grit, in thin section, under the microscope. And even then neither Sorby nor his contemporaries appreciated the value of the invention. Twelve years more passed before the method was made applicable to the purposes of petrography through the efforts of Ferdinand Zirkel, now professor of petrography at Leipsig. During Sorby's travels in Germany, in 1862, he became acquainted with Zirkel, then a student of mining at Bonn, to whom, in frequent excursions that they made together, he communicated the results of his studies with the microscope, and imbued the young student with his own enthusiasm.

During the winter of 1862–3 Zirkel began a careful study of minerals in the thin section. It was soon found that the minerals exhibited under the microscope characters altogether different from those noticed in the hand specimen. The most delicate of these were those which depended upon the action of the crystal upon polarized light. In order to appreciate some of these, it will be necessary briefly to describe the modern petrographical microscope, the essential features of which were embodied in the instrument which Zirkel used in his preliminary studies during the years 1862–3.

The common form of petrographical microscope is similar, in general construction, to that in use for biological study. The stage is so constructed as to be capable of revolution about a vertical axis, and allows the measurement of plane angles by being furnished with a peripheral graduation. Below the stage is adjusted in the axis of the instrument a Nicol prism for producing polarized light. This prism is called the polarizer. A second Nicol prism, called the analyzer, may be introduced above the objective.

The sections of a given mineral will, in general, show by their form in what direction they are cut, the external planes of the crystal being represented by the straight lines which limit the section (unless, owing to cleavage, the section has broken in grinding). In like manner, the cleavage planes will be shown in the section as series of parallel cracks, the nearness of which to each other is an index of the perfection of cleavage.

Owing to the different absorption of light, in different crystallographic directions, the mineral section often changes color as the stage of the microscope is revolved, and this may be very characteristic of a given species.

The analyzer is so adjusted that its plane of vibration is perpendicular to that of the polarizer, so that, together, they produce a total extinction of the light, if no doubly refracting substance is introduced between them. On introducing a mineral section between the two Nicol prisms, one of two phenomena will be produced. Sections of non-double-refracting minerals, as well as sections cut in particular directions from some double-refracting minerals, produce no effect whatever. Nearly all sections, however, of double-refracting minerals, when introduced between crossed Nicols, produce marked phenomena. On revolving the microscope stage, the field becomes black once for each time that the stage is turned through an angle of 90°. In a complete revolution, therefore, the light is extinguished four times. In intermediate positions the section shows more or less brilliant polarization colors, which are dependent on the mineral species, as well as on the thickness of the section and the direction in which it is cut. It is further noticed that sections of different double-refracting minerals, which produce these phenomena, if placed in similar initial positions, must be revolved through different angles before extinction of the light is produced. These so-called *extinction-angles* show the position in the crystal of the *axes of elasticity*, and are as characteristic of a given species as is the cleavage angle.

By introducing a convex lens between the polarizer and the section, and removing the eye-piece, the so-called interference figures are produced. These may be either uniaxial or biaxial, and if the latter may have a large or small optical angle. They may be positive or negative, and may disperse the light according to different laws. The position of the interference figure, with reference to crystallographic directions, is a matter of the greatest significance. All of these phenomena to be appreciated must be carefully studied, and, though their explanation is most conclusive when studied with a comprehension of the undulatory theory of light, complicated analysis is required. These explanations may be found in the text-books of Rosenbusch* and Groth.†

It is sufficient to state that, by means of such optical tests, it is possible, and in the majority of cases an easy matter, to identify the different minerals when present in microscopic crystals in a rock section.

As soon as the microscope came into general use, it was found that many minerals which had been considered rare occurred widely distributed in microscopical crystals. Other minerals whose crystalline form could not be determined by the ordinary methods gave most conclusive proof of their crystal system by their optical properties. Not only did the microscope reveal the character of the individual minerals composing a rock, but those minerals which were the first to form when the magma was consolidating, were shown by their perfect outlines. The study of massive rocks, from widely separated localities, has shown that the order of crystallization has been, with few exceptions, the same for all. The great leader in petrography, Heinrich Rosenbusch, has expressed this order for the holocrystalline rocks by four generations, viz:—(1) Ores and accessory minerals, (magnetite, ilmenite, apatite, sphene, etc.) (2) The iron-magnesia minerals, (olivine, augite, hornblende, and mica). (3) The feldspathic constituents (feldspar, nephelene, leucite, etc.); and (4) Quartz. The order of crystallization of the minerals in a magma is, therefore, one of decreasing basicity.

The experiments which have been carried out with artificial magmas have

* Mikroskopische Physiographie der petrographisch wichtigen Mineralien. Stuttgart, 1885.
† Physikalische Krystallographie. Leipsig, 1885.

so far shown the conditions under which many of the rock structures are produced, that we are often able to state the conditions under which a given rock solidified from the microscopic examination alone. Those rock structures which from a study of modern volcanic action we are led to believe are the result of consolidation at or near the surface of earth have been yielded by artificial magmas, which were subjected to conditions of more or less rapid radiation. The granitic structure has never been produced artificially, and the conditions of occurrence of rocks in nature which possess this structure, are such as to leave little room for doubt that their formation took place far below the earth's surface, where radiation of heat was *extremely* slow.

The more the crust of the earth is studied, the more forcibly is it shown that the rock masses of which it is composed are constantly changing. In some parts, generally below the surface, the rocks are becoming more crystalline from the action of heat and pressure; while at the surface alteration of minerals is taking place, yielding more soluble substances, of which the hydrous minerals and the carbonates are the most common. The earth's crust is, in fact, a huge laboratory in which reactions are constantly taking place, some of which we have thus far been unable to reproduce. This is, probably, owing to the impossibility of introducing into our experiments the proper conditions, particularly those of time and uniformity of temperature. From these changes in the composition of rocks, we learn that each mineral, in any given rock-mass, possesses a more or less complicated life-history, which is, in many cases, comparable for variety of change with the life-history of some of the organized plants and animals. These life-histories form a special field for the microscope to explore, and the brilliant efforts of Lossen, Törnbohm, Hawes, and a number of others, have shown what may be realized in this direction.

No attempt should be made to mention some of the more important attainments in the science of petrography without reference to the work of Hermann Vogelsang. At about the time that Zirkel undertook the microscopic study of minerals, Vogelsang began his investigations on the phenomenon of crystallization. He was able to retard the process of crystallization by mixing the solution with Canada balsam. Microscopic bodies, more elementary than crystals, were discovered and carefully studied, to which he gave the name of crystallites. These bodies were found to fuse together in the formation of crystals. Vogelsang's work entitled *Die Krystalliten*, which was published by Zirkel* after the death of its author, remains a monument to his ingenuity and carefulness.

The importance of the results obtained in the microscopic study of rocks, and the increasing number of workers in that field, warranted the publication of two text-books in 1873, which were intended to embody the most important results that had been realized. One of these was the work of Zirkel and was entitled, *Die mikroskopische Beschaffenheit der Mineralien und Gesteine*. The author of the other was Heinrich Rosenbusch, who is to-day the acknowledged leader in the science of petrography. His work was entitled, *Die mikroskopische Physiographie der petrographisch wichtigen Mineralien*. In 1877 he published a second volume entitled, *Die mikroskopische Physiographie der massigen Gesteine*. These two volumes have been revised and largely rewritten, the first appearing in its new form in 1885, and the second in 1888. Aside from the ordinary scope of a text-book, they contain a complete record of obtained results previous to the date of publication.

The researches of Fouque and Michel-Lèvy, and others, on the composition and structure of artificial magmas; of Boricky and Behrends in developing

*Bonn, 1875.

the method of microchemical reactions; of Leydolt, Rose, Haushofer, and Baumhauer, on the etched figures on crystal planes; of Thoulet, Goldsmidt, Klein, and others on the separation of mineral components by means of heavy solutions: all these are the offspring of microscopic petrography, and represent some of the methods of which the modern petrographer makes use to confirm his optical study of minerals.

Biology of fresh-water Sponges.—II.*

By EDWARD POTTS,
PHILADELPHIA, PA.

My own first experience in the propagation of fresh-water sponges may prove instructive in various ways. Late in the autumn of the year 1879, in a pond within the 'Centennial Grounds,' Philadelphia, I found for the first time a living sponge. It was a vigorous, branching specimen of *Spongilla lacustris*, charged with gemmules in all parts of its structure. A fragment firmly attached to a stone was taken home and placed in a gallon 'specie-jar' with water, in the hope, begotten of inexperience, that it would continue to grow, exhibit its inflowing and exhalent currents, etc. On the contrary, and as I now know, almost necessarily, it died, and in a few days the water became insupportably foul. It was changed and another trial made, which resulted as before. This time the jar was thoroughly cleansed; the stone with the attached sponge was taken out and held long under a flowing hydrant before it was replaced in the jar, which was now left in an outer shed and, very naturally, forgotten. Weeks passed and winter came on, and one severe night the water in my jar was frozen solid and the vessel fractured. I supposed that the low temperature to which it had been subjected would prove fatal to the germs, but, as the specimen was a fine one, it seemed well to save it, even in its skeletonized condition. So, when its icy envelope had been melted off, the sponge was again thoroughly washed until all the sarcode was removed, when, in a fresh jar, it again became a parlor specimen.

I do not clearly remember when signs of germination were first observed. It was probably in January, as during that month I find that artificial conditions very frequently bring about the hatching of such animal germs as those of the polyzoa, etc. I detected first a filmy, grayish-white growth that seemed associated with the detached gemmules which lay in the groove around the bottom of the jar. A gray, featureless growth at first,—then spicules were seen, in slightly fasciculated lines, attached to the glass and reaching upward, then spreading out fan-like and branching. These were, of course, covered with sarcode, nearly transparent at first, and through the filmy surface pores and ostoles could be detected with a pocket lens. The latter was surmounted by the so-called 'chimneys' or cone-shaped extensions of the dermal film; and through the apertures at their summits effete particles could almost constantly be seen, puffed out, as if thrown from a volcano and then blown off by the wind.

These products of single gemmules did not, as time passed on, greatly increase in size; possibly, because of deficient nutriment in the unchanged water of the jar; but, crawling upward along the glass to an average height of an inch or less, left the naked spicules in place behind them as so many ladders or 'stepping-stones of their dead selves' by which they had reached to 'higher things.' Near the summit, one or more new gemmules would sometimes be formed, after which the mother mass entirely disappeared.

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* Reprint of the introduction to a monograph of the fresh-water sponges read before the Philadelphia Academy, May 31, '87.

So much for the amount of growth from single gemmules. Where, however, they were thickly sown, or germinated *in situ* upon the stone, so that the contents of several could mingle and flow together, the resultant sponge was very much larger. The mass, if it may be so called, covered, at its best, nearly one-third the surface of the jar; while those gemmules remaining upon the stone and amongst the spicules of the old sponge, continued to germinate, to form abundant sarcode and spicules, and, at least in one place, to throw out a long unsupported branch or finger-like process, that ultimately reached a length of two or three inches.

Of course it was impossible to bring the higher powers of a compound microscope to bear upon a sponge growing under such circumstances; a strong Coddington lens was the best that could be applied to this work: but a very fair share of success was obtained by the device of scattering small squares of mica among the growing gemmules, which, when covered by the young sponge, could be removed to the stage of my instrument, covered with water in a compressorium and examined comparatively at leisure. It was a perpetual cause of astonishment to me to see so large a production of silicious spicules from a single gallon of water, in which the chemist would probably have failed to find any such constituent. It is worthy of consideration, however, whether such silica as composed the older spicules may not, at least when under the influence of the growth force of the younger sponges, be to some extent soluble.

As to processes of gathering—I have already mentioned the advantages obtained by the use of the 'scraper net' in relatively deep water and in connection with perpendicular timbers, etc. At depths of two feet or less, great facility of action is gained by wearing high rubber boots and wading after our specimens, to pick from the bottom stones, sticks or pieces of waterlogged timber, under which they may be concealed. Where the water is deeper, of course a boat must be used to approach the floating, submerged or dependent sponge-bearing substances. A large, strong knife, or a paper-hanger's scraper, will be found convenient for hand work at short range. A case containing trays an inch or so in depth is suitable for carrying the smaller specimens; the larger will of course require vessels of greater size. On reaching home or headquarters it is well to select some specimens of characteristic shapes and containing gemmules, for storage in dilute alcohol, making use of wide-mouthed bottles to avoid crushing them. The rest may be spread upon boards in sheltered situations, in the shade (for the sun bleaches them rapidly), and left to dry, turning them every few hours to prevent decomposition. If time is limited or the specimens are large, artificial heat may be necessary; but, whatever process is used, the drying must be *thorough*, or mould will soon cover the sponges with a mycelium, which may be beautiful enough in itself, but is far from agreeable or sightly as a feature of the sponge. Whether they are to be dried or preserved in alcohol, they should be dealt with promptly and on no account left to lie long in the water after being gathered. Preserve from dust in covered boxes.

For the determination of species a few general directions may suffice, and even these will be soon modified to suit the tastes or the ingenuity of the worker. It is assumed that the investigator has already noted the general appearance of the sponge in hand, its color, size, compactness; whether simply encrusting, or cushion like, sending out finger-like processes, etc. These indications may help an experienced collector to a guess, but there are very few species that even such a one could name, with any confidence, before he had made and examined microscopic preparations of the same.

A stand, supporting a dozen or more test tubes, say three-fourths of an inch in diameter by an inch and a quarter in depth; a dropping bottle con-

taining nitric acid, and the usual materials and apparatus for mounting in balsam, are all the appliances needed. As the processes to be described are certain to disturb the normal relations of the several classes of spicules to each other, it is well, before the dried specimen has been much handled, to separate some clean portions of the outer or dermal film, lay them upon a slide and mount in balsam without further preparation. An examination of this may determine the presence and decide the character of the dermal spicules, if there are any pertaining to the species in hand. This precaution is necessary in view of the displacement of parts just mentioned, and also on account of the indiscriminating habit of the sponge-currents during life, which almost necessarily charge the tissues with various foreign particles, including vagrant spicules of its own and neighboring species. In practice, the rightful presence of dermal spicules in any species is often so doubtful that it can only be settled by an examination of young sponges, grown under observation, from isolated statoblasts, whose identity has been satisfactorily determined.

Next, separate from the sponge some minute fragments containing skeleton spicules, the dermal and interstitial tissues, and a dozen or more gemmules. Place several of the last named, with a few adherent skeleton spicules, upon the centre of a fresh slide, bring to the boiling-point in one of the test tubes five or six drops of nitric acid, and by the aid of a dropping tube apply a single drop of the hot acid to the gemmules upon the slide. While the acid is partially destroying their cellular or granular crust, pour the remaining fragments into the acid left in the test tube and boil violently until all the tissues are destroyed and the spicules left as a sediment upon the bottom of the tube. Fill up the tube with water and stand it aside to settle, which may take an hour or more. The few minutes that have elapsed will probably have been as much as the gemmules upon the slide will bear. They must not be left so long as to destroy the chitinous coat, nor is it well, though a common practice, to *boil them upon the slide*, for this often smears and disfigures it with frothy matter. Remove most of the acid by trickling drop after drop of water over the slide while held in a slightly inclined position. Wipe off all the water that can be reached and apply repeated drops of strong alcohol to take up the remainder. When this is so far accomplished that the gemmules will absorb benzole freely and receive their covering of benzole or chloroform balsam without *clouding*, apply the balsam and a cover glass. This process of removing moisture by the use of alcohol, rather than by drying over a lamp, is preferred, although it requires more care and time, because the gemmules are less likely to be distorted in shape and the cells of the crust to become filled with air if they are kept always under fluid. Yet if the mounted gemmules, when examined, appear black, showing an accidental intrusion of air, much of this can be removed by carefully heating the slide over a lamp.

If this mount has been successful, the gemmules are now so transparent that their surrounding spicules can be readily seen and the genus determined by the aid of the 'Key' hereafter given; but a better view of the detached spicules is necessary, and may be obtained by mounting some of the contents of the test-tube. If the lately suspended spicules have now settled, carefully pour off all the water except one or two drops, though if there has been much acid used it may be better to wash them a second time. Shake up and place a sufficient quantity upon one or more slides, being careful not to leave the contained spicules in too dense a mass. I have found it best to allow the water to evaporate from these slowly, as, if hurried over a lamp, each spicule is often margined with minute globules that it is impossible afterward to remove. However, when the slide is apparently quite dry, it

may be safely exposed a moment to the heat, to make sure of it, and then covered with balsam and glass as usual.

The investigator has now before him all the elements necessary for solving his *specific* problem, according to the formulæ which follow :—the normal sponge, the dermal film, the transparent gemmule, and a display of the detached spicules. Neither would alone answer, but the series will settle all points, excepting in the case of the genus *Carterius*. When this is suspected the gemmules should first be examined *dry;* and, in preparation for mounting, great care should be taken to avoid the destruction of the tendrils (cirri) by the prolonged use of strong acid. Expert microscopists will improve their gemmule mounts by dividing some of them with a thin knife, endeavoring to make the section through the foraminal aperture. This, in the case of species having long birotulates, such as *Meyenia crateriformis*, is of the utmost importance.

'Seniors' in microscopy will please pardon the minutiæ of the processes just given as they were necessary to make them available for the 'freshmen.' All are reminded that the above directions as to collection and examination refer to mature sponges only. It is seldom safe, or even possible, to *name* one in which no gemmules can be found. If a course of study is undertaken involving the histology and physiology of fresh-water sponges, many peculiarities will of course be observed that have not been alluded to here. One of them concerns the development of the spicules, and if not understood will pretty certainly mislead the beginner into the supposition that he is examining a novel species. Both the skeleton and dermal spicules of *young sponges* are frequently marked with bulbous enlargements at the middle, and often half way between the middle and each end of the spicule. These seem to indicate an immature condition, as they disappear when the spicules are fully formed.

EDITORIAL.

We announced some time since (Journal, viii, p. 134) that Mr. A. J. Doherty, of Manchester, would shortly visit this country. The plan then projected was interfered with, but Mr. Doherty has lately written again concerning his intentions. From his letter we quote the following :—'I am in negotiation with the San Francisco, the Denver, and the Wellesley College Microscopical Societies as to my giving before them demonstrations in practical microscopy. It is quite possible that I shall leave here for the United States towards the end of March, or early in April. * * * I feel certain that the demonstrations will be both interesting and instructive, and the exhibit of slides, etc., with the lantern microscope, will give pleasure to all who witness it.'

The demonstrations include animal and plant section cutting, single and double staining, anatomical injection, selecting and arranging foraminifera, mounting in balsam and other media, construction and use of the lantern microscope. Any societies which are prepared to secure one or more of the demonstrations will unquestionably derive very great benefit, and we shall be glad to correspond with them relative to the matter.

CORRESPONDENCE.

Making Mounts Photographic.

To The Editor :—There is a phase of mounting which could well be impressed upon the attention of microscopists. That is, to make all mounts with reference not merely to use under the tube, but with reference to good photographic results. I

think I am justified by experience and study in saying, what has been well said before, that whatever can be seen with an objective and eye-piece can be photographed as clearly as it can be seen, provided proper methods of preparation for photography are followed. I think it may be further stated that such methods of preparation will not diminish their value under the tube. Go through a cabinet of ordinary mounts and see how few are photographable! The enormity of the thing appears when we consider that nearly all classes of mounts, including opaque, may be readily photographed if properly prepared. To this, however, there are a few exceptions. The additions to general knowledge of matters microscopic which could be made, if all working microscopists would prepare with reference to photography, is simply enormous.

ROCHESTER, N. Y., *March 16, 1888.* GEO. W. RAFTER.

NOTICES OF BOOKS.

Journal of Morphology, Vol. I, 2.

The last half of the first volume of this new journal has made its appearance, and is in every way equal to the expectation created by the first volume. It contains five articles, as follows:—(1) Phenomena of the egg during maturation and fecundation, by C. O. Whitman; (2) Embryology of Petromyzon, by W. B. Scott; (3) Embryology of the Lizard, by Henry Orr; (4) Fœtal membranes of the Marsupials, by Henry F. Osborn, of Princeton; (5) Observations on the mental power of Spiders, by Geo. W. and Eliz. G. Peckham. It would be a pleasure to abstract these articles, but that we are not permitted by our space to do. We hope to do as much for at least some of the articles on a future occasion. We feel a pride in thinking that it is an American production, and in realizing how very favorably it compares with similar magazines of foreign countries. It should find a place in every college library. It is not only a necessity to advanced students of biology, but it shows general readers what animal morphology is and how students think and work.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

WANTED.—Parasites and books on Parasites and other micro. subjects. Will give Anatomical, Pathological, Botanical, Micro-fungi, Zoophytes, Polycistinæ, Foraminifera, Parasites, and other slides in return.
FRED. LEE CARTER, Gosforth, near Newcastle-on-Tyne, England.

Wanted, Diatomaceous earth from Mégillanes, Bolivia, South America. Can give in exchange either Diatomaceous earth from New Zealand or cash.
E. MICHALEK,
I. Fleischemarkt, No. 1, Vienna, Austria.

Mounted sections of Fœtal Lung (5 months), sections across entire lobe, $\frac{1}{2000}$ in. thick, beautifully stained, in exchange for first-class pathological slides. W. C. BORDEN, M. D., U. S. A.,
Fort Douglas, Utah.

Correspondence relative to exchange in microscopical material or prepared mounts.
HENRY L. OSBORN, Hamline, Minn.

Wanted, earths, recent diatoms, and miscellaneous objects for mounting. Only first-class material offered or desired. MARY A. BOOTH, Longmeadow, Mass.

Fossil Diatomaceous deposits (marine) wanted from Bermuda, Virginia, Maryland, California, etc.
I. ELLIOTT, Ardwyn Villa, Aberystwith, Wales, England.

Labels for slides. EUGENE PINCKNEY, Dixon, Ill.

Notices.—All communications for publication should be addressed to Henry Leslie Osborn, Hamline University, Hamline, Minn.

Subscriptions, and all matters of business, should be addressed to the Manager, Chas. W. Smiley, P. O. Box 630, Washington, D. C.

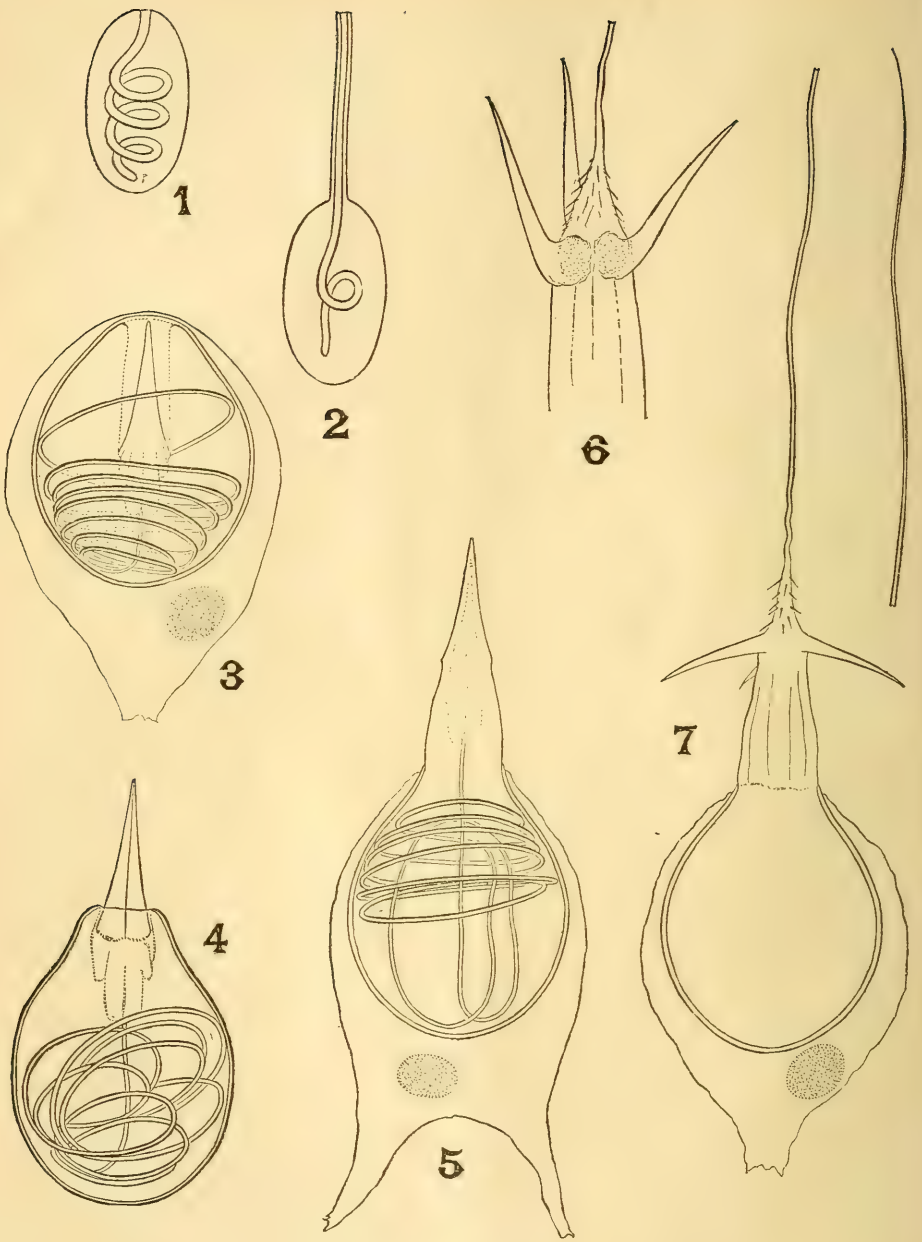
Subscription price $1.00 PER YEAR *strictly in advance. All subscriptions should end with the December number.* A pink wrapper indicates that the subscription has expired. A date on the wrapper indicates the month to which payment has been made.

Orders for slides advertised by A. J. Doherty in the Journals from January to April, 1887, may be sent through the Business Manager, P. O. Box 630, Washington, D. C.

A few copies of Leidy's Fresh-Water Rhizopods, of North America, can still be had at $5.00 per copy.—P. O. Box 630, Washington, D. C.

Remittances should be made by postal notes, money orders, or by money sent in registered letters. Drafts should be made payable in Washington, New York, Boston, or Philadelphia, to the order of the Manager.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the following prices which are net:—Vol. II (1881) complete, $1.50; Vol. III (1882), out of print; Vol. IV (1883) complete, $1.50; Vol. V (1884) complete, $1.50; Vol. V (1884), Nos. 2–12, $1.00; Vol. VI (1885), $1.50; Vol. VII (1886), $1.00; Vol. VIII (1887), $1.00. As calls for Volume I sometimes occur, those persons having copies to dispose of would do well to inform us, and to state their prices.



THREAD-CELLS OF HYDRA.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. IX. MAY, 1888. No. 5.

Note on the mechanism of the thread-cells in Hydra.

BY EDMUND B. WILSON,

BRYN MAWR, PA.

I. Since Ehrenberg's discovery of stinging 'thread-cells' (otherwise known as nettle-cells, lasso-cells, nematocysts, etc.) that are so characteristic of the true Cœlenterata, many accounts have been given of their structure and mode of action, and they have been, perhaps, nowhere so often examined as in the fresh-water *Hydra*, a form that has been repeatedly studied by good observers, and is examined by every tyro in practical biology. It is, therefore, rather surprising that even the most recent monographs and text-books, while correctly describing the action of the smaller thread-cells, give but an imperfect account of the beautiful mechanism by which the larger barbed forms are discharged and are enabled to force their delicate threads into resistant objects, such as the tissues of the *Hydra's* victim.

As far as I am aware, the only accurate published account of the matter is that of Möbius,* who gives a brief description, with four rude but recognizable figures, of the barbed thread-cells of *Hydra*. In all subsequent works that I have seen the precise structure of the thread-cell (nematocyst), as distinguished from the surrounding protoplasmic structure (cnidoblast), is not very carefully considered, and most of the figures are either incomplete or altogether misleading.†

II. It is known that *Hydra* has three kinds of thread-cells, which may be designated as small, middle-sized, and large (the first of these has been asserted, though probably on insufficient grounds, to be simply an undeveloped form). The small forms are ovoid, or slightly pyriform in shape, with a very short, stout thread which makes but a single turn within the sac and after discharge is usually coiled like a snail-shell. The middle-sized forms are narrower and more elongate, regularly ovoid, and the thread is disposed in numerous coils. After discharge the thread is long and straight, with a rather blunt tip, and, like the sac, it stains intensely with aniline dyes. The large

* Ueber den Bau, den Mechanismus und die Entwickelung der Nesselkapseln: Abhandlungen aus dem Gebiete der Naturw., herausg. v. dem Naturwiss, Verein zu Hamburg, V, 1866.

† It is proper to add that the mechanism of the barbed thread-cells of *Hydra* was fully made out by Mr. Emerton and myself several years ago without knowledge of the studies of Möbius.

EXPLANATION OF FIGURES.

(*All the figures were drawn from nature by J. H. Emerton*).

Fig. 1. Diagram of undischarged thread-cell, showing the thread as an infolding of the wall of the sac.

Fig. 2. Diagram of discharging thread-cell, showing the eversion of the thread.

Fig. 3. Barbed thread-cell of *Hydra* surrounded by the cnidoblast, showing the sac, infolded pouch, pyramid, and coiled thread. Highly magnified.

Fig. 4. Beginning of the discharge, the pyramid having ruptured the membrane, and the pouch having partly unfolded.

Fig. 5. Completion of the first part of the discharge, the pouch having evaginated to form the 'neck.'

Fig. 6. Separation of the barbs (the thread having already shot forth from between them).

Fig. 7. Completely discharged thread-cell (only a part of the thread is shown), with the sac of the nematocyst still enclosed in the cnidoblast.

forms have precisely the same shape as the small, but are three or four times as large, and the thread makes numerous turns within the sac (fig. 3). The discharged thread is extremely long and slender, tapers to a point of extraordinary fineness, and is armed near the enlarged base with three hard, sharp spines, or barbs, that are usually directed backwards (fig. 7).

The small and the middle-sized forms are discharged simply by the eversion of the thread, as illustrated by the diagrammatic figs. 1 and 2. The large or barbed forms have a more complicated mode of action, the nature of which was first pointed out to me by Mr. J. H. Emerton while making sketches for the drawings reproduced in the accompanying figures. Before the discharge the barbs lie within the thread-cell, folded exactly together, with their points in contact, like the legs of a closed tripod, or triple compass, thus forming a three-sided pyramid, or dart, with an exceedingly sharp, hard point. The base of the pyramid fits accurately into the bottom of a pouch (the 'barbed sac' of authors), that is folded into one end of the thread cell, and is continuous at its mouth with the inner or lining membrane of the double-walled sac; its point is braced against a membrane that stretches across the opening of the pouch, and is continuous with the outer membrane of the sac (fig. 3). From the base of the pyramid a peculiar folded structure hangs down into the cavity of the sac, but its precise nature has not been made out.*

Both Mr. Emerton and myself have repeatedly studied these thread-cells at the moment of discharge, taking advantage of the fact that the action occasionally takes place slowly or incompletely, so that every step may be accurately followed. The discharge may be described as consisting of two distinct acts:—First (as a result no doubt of pressure exerted on the sac by sudden contraction of the surrounding protoplasm), the point of the pyramid is suddenly forced through the membrane, the whole pyramid is violently projected outward, and the pouch in which it lay is evaginated to form the 'neck' of the discharged thread cell (fig. 4 and 5). Second, the pyramid splits asunder into three parts (fig. 6), which instantly turn backwards (being as it were hinged at the base) to form the three barbs, and at the same instant the thread is shot forth, being everted from a point in the middle of the triangle formed by the bases of the barbs (fig. 6 and 7).

This account helps, I think, to explain certain rather puzzling features of the action of thread-cells of this type. It explains the explosive violence of the discharge, for this is due to the sudden rupture of the membrane by the point of the pyramid at the instant when the pressure upon it reaches a certain maximum limited by the resisting power of the membrane. It explains, also, the penetrating power of the thread, for the keen, hard point of the pyramid easily punctures the tissues of the *Hydra's* victim, held fast by the tentacles, and the subsequent spreading apart of the barbs not only fixes the sac, but also clears a space into which the delicate thread may unroll.

There can be little doubt that all thread-cells of this type (which are widely distributed among the Hydrozoa) are discharged in a similar manner, and it would be interesting to search for the causes by which so curious and perfect a microscopic mechanism has been evolved, and the successive stages through which it has passed.†

BRYN MAWR, *March, 1888.*

* The structure of the undischarged thread-cells may best be studied in specimens treated on the slide with one per cent. acetic acid, and afterwards stained with fuchsin or aqueous magenta. The highest available power should be used.

† The paper of Möbius already cited deals mainly with the thread-cells of *Caryophyllia*, which do not possess the three large barbs; but his figures and brief description of the barbed thread-cells of *Hydra* show that he clearly understood their action. It may be added that nearly fifty years ago Erdl published recognizable figures of these thread-cells, both before and after discharge, and he seems to have understood the action of the pyramid ('*Pfeil*'), though he fell into the error of supposing it to be capable of repeated action by withdrawal into the sac after discharge.

Soap-bubble solutions and a slide for observing soap-bubble films.*

By F. T. CHAPMAN,
WASHINGTON, D. C.

A simple means for showing soap films, by means of the microscope, may consist of a thin strip of wood (3 in. by 1 in.), or other material, with a metal plate secured to it. The plate should have one end bent upward from the

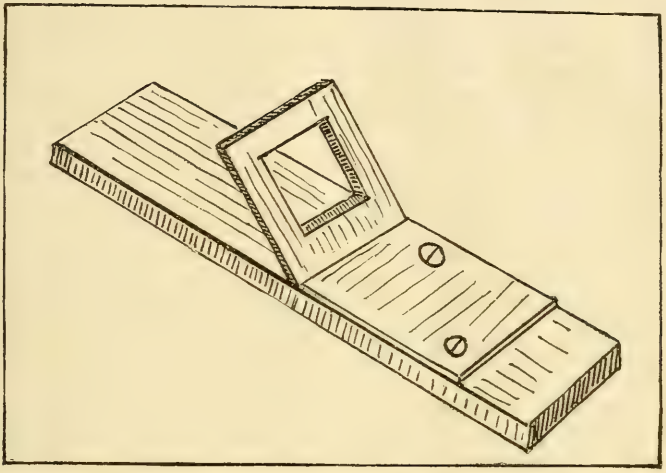


Fig. 1.—Slide for Soap Films.

strip, at an angle of about 45°, and have a square hole through it. The film increases in brilliancy as it grows thin. The light should be thrown on the film from above, so that the beam will be reflected up the tube of the instrument. The proper angle can readily be found by trial.

Following are some directions for making soap-bubbles :—

I. Shave Marseilles (castile) soap and dry thoroughly in the sun or on a stove.

II. Put the dried shavings of soap in a bottle with alcohol of exactly 80% strength (specific gr. 0.865), sufficient to form a saturated solution at 60° Fahr., the solution then marking 74° on the centesimal alcoholometer, with a density of 0.880. The solution must be made cold, as warm alcohol would dissolve too much soap, and the solution would solidify when cool.

III. Make a mixture of glycerine and water, so as to mark 17.1° Baumé, or have a density of 1.35 at 68° Fahr. This solution can be made of equal parts of the most concentrated glycerine and water, and it is well to heat the solution in a water bath.

IV. To make the final solution, take 100 parts, by volume, of the glycerine solution (III) to 25 parts of the soap solution (II), mix and boil to expel alcohol. When cool, pour into a graduate and add water to equal 100 volumes. Then filter several times to remove oleate of lime.†

Plateau's soap-bubble solution is prepared as follows :—

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* Read before the Washington Microscopical Society at its 72d Meeting.

† Common glycerine is apt to make the solution turbid on account of the presence of gypsum and lime.

A funnel with a plug of cotton makes the best filter, as the flow can be regulated by the tightness of the cotton in the funnel.

Soap bubbles, not more than four inches in diameter, and supported on a tripod under a bell-glass, are said to last for an hour.

The preparation is suitable for Plateau's experiments with thin films, soap bubbles, &c. From Poggendorff's Annalen., Scientific American, vol. 35, page 127, Aug. 26, 1876.

Dissolve one part of Marseilles soap in forty parts of water (rain or distilled), which may be warmed.

When cool, filter through very porous filter paper and add Price's glycerine in the proportion of eleven parts of glycerine to fifteen parts of the soap solution.

Shake thoroughly and allow the solution to stand for seven days where the temperature will not fall below 67° Fahr. Then cool to 37° Fahr. and filter, keeping a bottle of ice in the funnel. The first parts filtered should be refiltered, using very porous filter paper.

Halbrook's brown oil silk soap, or his Gallipoli soap, and Sheering and Glatz's glycerine work very well.

Long standing and decantation from sediment may take the place of the second filtration. After all the trouble, the mixture may not give very good results.

An excellent soap-bubble solution may be formed by a compound of oleate of soda and pure glycerine. Bubbles two feet in diameter may be blown, and bubbles have been kept, under glass, for 48 hours.

A good and easily prepared solution may be made by shaving four ounces of Marseilles, or, better, of pure palm oil soap, and placing it in a quart of distilled or rain water. Shake until a saturated solution is formed and let it settle for a few hours. The solution should then be clear. If otherwise, pour off the water, and add fresh water to the same soap and try again. To the clear solution add about one-half the quantity of glycerine that is absolutely pure. The presence of the least quantity of acid in the glycerine is fatal to good results, and, therefore, it is recommended that for any soap-bubble solution the ingredients be the best and purest obtainable, and that chemically pure glycerine be used. It costs about 75 cents per pound.

Instantaneous Mounting in Farrant's Gum and Glycerine Medium.*

By R. H. WARD, M. D.,

TROY, N. Y.

For facility of use too much can scarcely be said in favor of Farrant's Gum and Glycerine Medium. It may be inferior to glycerine jelly for mounting sections that are large and not liable to be injured by heating, as both are doubtless inferior to Canada balsam for objects that are not too transparent in the latter, or that can be rendered sufficiently conspicuous by staining, and that can be dehydrated and transferred to the balsam without injurious modification of structure. But it answers excellently for a very large variety of specimens, both animal and vegetable, that can be studied to advantage in water or in glycerine, and that, in the former case, can be transferred to a dense mucilaginous medium without destruction by exomose. For such objects it very nearly accomplishes the paradox of enabling one to mount specimens without the trouble of mounting them.

Those who prepare objects for the trade, and students who are working in the laboratories as learners, make a business of the hardening of objects, the cutting of sections, the handling of reagents, the selection and manipulation of varnishes, etc.; and many amateurs and even professional admirers take pleasure in imitating, and often excelling them in this recreative work.

Many professional microscopists, however, find their time filled with other engagements. Objects almost without number are examined for purely scientific investigation, or for sanitary, economic, medical, or legal purposes, and then are inevitably thrown away for want of the time required, but not just then available, for mounting them. Such objects are often examined in

* From a paper read at the Microscopical Section of the Troy Scientific Association.

glycerine; and, proving interesting, they are laid aside unsealed only to be found spoiled when next seen, or are ringed with varnish, without a cell, to make a mount that will be short lived by reason of the running-in or splitting-off of the cement. It is no more trouble to place such objects, and cover them, in the gum and glycerine medium at first, than in plain glycerine: and then they are already mounted to begin with, and they can, as desired, be washed off the next day, or be neglected for years without injury.

The following points may be of use to those not accustomed to this instantaneous method of mounting.

1. Use only sufficient of the medium. By a little care a drop of the right size can be employed, so that the cover-glass will be supported to the edges, but without enough surplus material to require the fussy procedure of cleaning off the excess. If any should require removal, leave it to be scraped off with a knife after drying for a few hours, instead of washing it off at once with water.

2. Breathe on the slide, and also on the cover-glass, just before making contact with the medium, to moisten the surface and thereby prevent entanglement of air bubbles.

3. Plunge the object into the drop of medium by means of a needle, or of a flattened lifter, without entangling air by unnecessary stirring; and remove with the needle point any bubbles that may be seen. Do not discard the specimen if a few small bubbles be included, as they may disappear in time.

4. The object may be taken from glycerine, or from a watery fluid, or even, sometimes, from diluted alcohol. Do not dry it enough to get air into the tissues, but be careful not to carry too much of the medium with it, as it is easy to introduce, in this way, enough water to make the medium too thin, or enough glycerine to prevent its drying properly.

5. Keep, within reach, a bottle of carmine or hæmatoxylin stain, the latter being capable, probably, of most general application; and try immersing in a drop of it, on a slide or in a watch-glass, such objects as are likely to take the stain promptly. Many delicate sections, or membranes, teased-out tissues or fibres, secretions containing interesting physiological or pathological structures, etc., will be stained exquisitely by being dipped in this a few seconds, on the way to the mounting medium, or at most by lying in it while the next object is being examined.

6. If the object be thin, no care is required after covering; but if thick, air may possibly enter at the side by shrinkage in drying, which should be corrected by keeping the mounts in sight a few days and applying, when required, a very small drop of the medium, not over but at one side of the incipient air bubble, so that it will run in in place of the air.

7. If the object prove valuable, but not otherwise, label and number it at once, and record in a systematic catalogue anything important that may be known about it.

8. If properly managed, the slide will need no cleaning after the mounting and labelling are finished. It should only require to lie untouched for a few days while the gum is drying at the edge of the cover-glass.

9. Any time, after a few weeks, months, or years, the slide may be placed on a turn-table and a ring of shellac varnish or Bell's cement be added. This will give a neat amber finish, and may keep the medium from distorting the object or the cover-glass by shrinking too much, or from becoming too hard, and granular, in case it has been incorrectly prepared or used.

By adopting this method of preserving suitable objects that may come under his examination, the busiest man may, in the course of years, prepare a valuable collection, without appreciable labor and almost without knowing that he is doing it.

Notices of New Methods.—III.

By GEORGE C. FREEBORN, M. D.,

INSTRUCTOR IN NORMAL HISTOLOGY, COLLEGE OF PHYSICIANS AND SURGEONS, NEW YORK CITY.

Sublimate as a Hardening Medium for the Brain.* A. Diomidoff.—Pieces of fresh brain, 1 c.c. in size, are placed in a 7% aqueous solution of mercuric chloride for five to nine days, then successively in 50%, 70%, and 96% alcohol. The pieces must remain in each alcohol for twenty-four hours. Tissues hardened by this method are easily cut and are readily stained with any of the aniline dyes, but unfortunately they cannot be stained by Weigert's hæmatoxylin method.

This method, according to the author, is especially valuable for experimental pathological work. Coagulation necrosis of the nerve elements, changes in the nuclei in traumatic inflammation, pigment granules, as well as cell alterations in progressive paralysis, dementia senilis, etc., are shown well.

New Methods of Preparing Nerve Cells. L. V. Thanhoffer†.—1. A bit of the fresh gray substance is placed between two cover-glasses, these are pressed together, forcing the bit of tissue out into a thin layer. The cover-glasses are then slid apart and heated over the flame of an alcohol lamp or Bunsen burner until the thin sheet of tissue becomes of a blackish-brown color. Then mount in Canada balsam.

In these preparations the nerve cells and their nuclei appear deep brown; blood vessels and their nuclei of a lighter shade. Glia cells and nerve fibres stand out sharply as a fine network.

2. As the sliding apart of the cover-glasses is apt to disturb the relations of the parts, the author recommends the following method:—A bit of the gray substance, the size of a hemp seed, is placed between two cover-glasses, with the addition of two or three pieces of thin paper placed at the edges. The covers are then pressed together as above. They are then placed in a solution of picro-carmine, or an aqueous solution of methyl blue. The stain penetrates very slowly. At the end of two days a band of tissue, 2 mm. wide, will only be stained; at the end of four days this will have increased to 4 mm. The cover-glasses are now removed from the staining fluid, washed in alcohol, and dried. Under the microscope, the cell bodies will be seen slightly stained, the nuclei of a darker shade, and the nucleoli of a still darker shade. The nuclei of the glia cells will be found stained quite deep, while the interstitial tissue will be colorless or very faintly stained. In many cases the cell bodies, as well as the interstitial tissue, remain colorless.

If the cover-glass preparations are allowed to remain in the staining fluid for fifteen days, the whole of the thin layer of tissue will become stained. At the end of this time they are removed from the staining fluid, washed in alcohol, then placed in oil of cloves for four days; then in xylol for two days, and finally cemented on the surface of a slide with xylol dammar.

Neutral Aniline Staining Fluid.‡ V. Babes.—This staining fluid consists of saturated solution of orange 125 c.c., saturated solution of acid fuchsin in 20% alcohol 125 c.c., alcohol 64 c.c., saturated solution of methyl green 125 c.c. The orange and acid fuchsin solutions are fixed, and then the alcohol and methyl green added gradually.

Sections of tissues stained in this fluid show blood cells stained orange-yellow, nuclei of polynucleated leucocytes green, their cell bodies deep violet, cell bodies of eosinophilous cells blackish-brown.

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*Zeitsch. f. Wiss. Mikros. iv, 1887, p. 499.
†Zeitsch. f. Wiss. Mikros. iv, 1887, p. 467.
‡Arch. f. Path. Anat. u. Phys. cv, 1886, p. 526.

Studies for beginners.—II.

By H. L. OSBORN.

THE YEAST PLANT—*(Continued from p. 42.)*

1. **Protoplasm** —This, as you look at it through the microscope, seems like a very fine-grained substance pervading the entire yeast. It is so nearly transparent that you may at first think that there is nothing there, but this delusion you may correct by searching until you find a dead yeast cell, from which the protoplasm has dissolved. You can also demonstrate the presence of the protoplasm by 'staining' with iodine. In staining, you may easily make the mistake of not allowing the fluid time enough to operate. This will depend on the strength of your solution, and may be a quarter of an hour or more. The protoplasm is the living substance of the yeast cell, and, after the parts of the cell have been demonstrated, I shall return to it for further remark. In working out all these points, remember that you are dealing with very small bodies and must use high powers and great patience.

2. **The cell-wall.**—This can be demonstrated best on dead cells or by crushing living ones. To do the latter thin the yeast so that you have only a very few cells under the cover-glass. Then cut a bit of blotting-paper the shape of the cover and lay it on the cover, then press on the blotter with your finger. You will, perhaps, succeed in pressing upon the yeast cells, which are spherical, hard enough to burst the wall and liberate the contents. You can now mount your slide on the stage of the microscope and search for one of the yeast cells. The search had better be conducted with the low power, and when a cell is found it should be left in the centre of the field while the high power is adjusted. Examination of the crushed yeast cell will show the wrinkled cell-wall and, very likely, some of the protoplasm spread about the break, and the empty yeast cell. In living yeast the cell-wall appears as a narrow band with two lines defining it outside the protoplasm.

3. **The vacuole.**—This is a round spot, of greater or less size, inside the protoplasm. It looks like an empty space surrounded by the protoplasm. In size it varies from a quarter of the diameter of the yeast cell to a half, or even more. There may be one, two, or even three vacuoles in one yeast cell. If so, they are all spherical and surrounded by the protoplasm. That the vacuoles are surrounded by the protoplasm is shown by the fact that you can see the protoplasm all around them, and then by focusing up above them or down through them you can see the protoplasm over and under them. The vacuoles are not really empty spaces, but are bubbles of water in the protoplasm—water which contains some soluble matters and is really sap. It is probable that the size of the vacuole increases with the age of the cell, and it is a fact that some cells can be found in which the vacuole extends almost to the cell-wall, leaving but little protoplasm inside the wall.

4. **The fat droplets.**—In addition to numerous very minute specks in the protoplasm, you can usually find in the yeast cells a few somewhat larger, but very small, very bright or (according to focus) very black spots. These are little droplets of fat. Their presence in large amount would argue ill-health of the cell or fatty degeneration, but a small quantity is naturally present on all occasions.

It may seem incredible to one unused to studying minute organisms to hear that 'those specks' show so much, but they positively reveal to any student, who approaches them aright, everything described and very much more besides. Any one, then, of our yeast cells, from the immense number in a cake of 'compressed yeast,' is a little oval body with a protoplasmic substance, an outside coat or jacket, a cavity of sap, and some drops of fat. Take a few

drops of your thinned yeast and put them into a tumbler of rain-water and put a few other drops in a thin syrup of sugar and rain-water. Set them aside a couple of days. You will then be able to learn some of the things which yeast can do. The two tumblers can best be kept in a warm place, and if they are examined, even after 24 hours, great changes will be found to have occurred. Those who wish may study these changes in advance of our description of them, which will be given hereafter.

(To be continued.)

The application of the paraffin-imbedding method in botany.*

By J. W. MOLL,

UTRECHT, HOLLAND.

It is my purpose to introduce into botanical science the paraffin-imbedding method which zoölogists generally have employed for several years with great success. The advantages of this treatment appear when combined with the methods of preservation in arresting protoplasm in its living form, in section cutting, and serial mounting. It not only enables the observer to make sections of very minute and tender objects, but to obtain sections through previously determined parts in consecutive order, and to keep in the relative position in mounting parts which are independent of each other in the section. Thus it is possible to make transverse sections of buds in which the position of the leaves remains unaltered and may be studied with ease.

This method has not come into use because it has not been properly combined with preservative methods for the especial requirements of vegetable histology. Vegetable parts preserved in alcohol are only with great difficulty permeated with paraffin. On the contrary, those which have been preserved in picric or chromic acid, or their mixture, are readily imbedded. This seems to be connected with the presence of cellulose in the vegetable tissue, which cellulose is somewhat macerated by the acids. The imbedding method has been tried most commonly for full-grown tissues, hence its failure; it is best suited for developing tissues—those containing but little cell-sap, a thin cell-wall, and much protoplasm, and these are the parts where its help is most needed; thus in longitudinal sections through the median line of growing points, serial transverse sections of the same object, etc. The imbedding method can very fortunately be combined with the methods of fixing living protoplasm in general use. Thus, in sections of the growing point, the processes of cell-division, with its several karyo kinetic figures, and in youngest cells vacuoles can be seen.

The method employed in a single instance may serve as a guide for other workers, to be varied from as occasions seem to suggest. The object studied was the growing points of primary roots of germinating seeds of a *Vicia Faba*, or secondary roots of bulb of *Allium cepa* (grown in water). First, tips of the roots are placed in watery solution (1%) of chromic acid; osmic acid, 0.02%; ½ acetic acid, 0.1%; to remain in the solution 24–48 hours. Then they are washed well in running water 5 or 6 hours. Then they are put through serial alcohols 20%, 40%, 60%, 80%, 95%, and 100%. They are then placed in turpentine, thence to mixture of turpentine and paraffin kept at 30–40° C., and finally to pure paraffin at 50° C. After 6 or 8 hours they are imbedded in a block ready for use. After cutting in ribbons the sections were stuck to the slide by the collodion and oil of cloves mixture, and can now be stained or covered with balsam, covered, and examined.

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* Condensed from *Botanical Gazette* for January, 1888.

Fauna and Flora of Hemlock Lake.

By GEO. W. RAFTER.*

[Micro-organisms in the water supply of Rochester, N.Y., was the subject of a recent paper by Mr. Rafter. The list, which seems appalling, is probably no greater than could be made out in the study of the water supply of most cities. Every one must be interested in an abstract of such a paper. The lake is about 7 miles long and one-half mile wide, with bold, steep shores, covered on the west side with primeval forest of oak, ash, chestnut, and hemlock. The list of animals found in water delivered to the city, or at the lake, is very interesting, though not alarming, as the creatures are all harmless. Since the report embodies the work of the Rochester Academy of Science for the past year, it shows how a society can do useful work and so secure the strong stimulus to continuance which comes with well-directed effort. Mr. Rafter has been aided by the society, and a very creditable piece of investigation is the result. The following is an abstract from the article. Justice to its author requires the statement that we have been obliged to omit many very interesting observations upon natural history which are given in the paper.—EDITOR.]

Nearly 150 forms are now known to this section by name, and there are probably 100 forms known to the section by sight which have not thus far been identified. Independent, therefore, of the sanitary value of such an investigation, this work has about it the absorbing interest which always attaches to a journey into new and hitherto unexplored regions. In addition to adding materially to the stock of knowledge of our water supply, there is a fair probability that when the work is concluded we shall have made very considerable additions to the stock of knowledge on this subject possessed by the world at large.

Not the least interesting fact brought out is the recurrence of certain forms at definite seasons of the year. In January and February, every glass of Hemlock water contains a number of specimens of the magnificent entomostracan, *Diaptomus pallidus*. In April and May, the generations of Cyclops, Bosmina, and Chydrorus appear, and as they disappear in July and August the procession is kept up by countless numbers of *Sida crystallina* and smaller numbers of several species of the genus Daphnia. Again in December and January we have the diatoms *Astrionella formosa*, *Cyclotella operculata*, and *Stephanodiscus Niagaræ* in countless number, while in midsummer hardly a single individual of these species can be seen.

To show the relation which subsists between the period of recurrence in our water supply of these minute animals and plants is a part of the task undertaken.

Beginning with the protozoa, we have the fresh-water sponge present in our water supply in considerable quantity. At the present time the spicules of what are probably *Spongilla fluviatilis* may be found in every filtering. The skeleton of the sponge upon which the slime-like sponge flesh or sarcode is supported is composed of silicious spicules slightly bound together by a small quantity of firmer sarcode. These spicules average about 1.100 inches in length, and are arranged in bands made up of several spicules lying side by side overlapping at their extremities. Besides the skeleton spicules there is another class known as the flesh spicules, either lying upon the outer film or lining the canals in the deeper portion of the sponge. These are usually much smaller than the skeleton spicules, and are not bound together in any way. A third class of spicules are embedded in the crust of the gemmules and may be

* From report of work done by the Rochester Academy of Sciences.

regarded as their defensive coating. The fresh-water sponges may be frequently found in rapid running water, attached to large loose stones, or the under side of timbers. They are also found on water-logged or floating timber and submerged stumps, and many of the species grow in deep water from ten to twenty feet or more below the surface. The fresh-water sponges are widely distributed. So far as known, most of the species prefer pure water, but some of them have been found to flourish in water unfit for domestic use. Their presence has been known to give water a very disagreeable odor and taste, as was especially noticeable at Boston in 1881, when it was found that a large quantity of decomposing sponge in one of the reservoirs was the cause of the trouble. Nevertheless, the fact that they exist in a public water supply need not be the cause of serious apprehension. It is not known that they have ever been the direct cause of disease.

Several rhizopods have been identified in filterings from the city mains, and of this class of life it can only be said that they must be taken when present in any quantity as indicating considerable impurity. Their natural habitat is to be found in the ooze along muddy borders and in the interstices of sphagnum growing in the margins of swamps. As a general statement, it may be said, therefore, that they are never found in quantity in waters about the purity of which there is no question. As yet only a small number of rhizopods have been seen in Hemlock lake water, but a study of the swamp at the south end of the lake would doubtless reveal a considerable colony of them.

Something like twenty species of infusoria are known to exist in Hemlock lake water as received at Rochester, and some of these are found in considerable numbers in nearly every filtering. Probably the most numerous, both as to number of individuals and species, are the *Vorticellæ*. *Euglena* has also been seen a few times in considerable quantity. *Paramecium* has been seen a few times in considerable quantity, but usually this representative filth infusorian is not found in fresh filterings. It is only after the filtering has stood and become stagnant that paramecium appears. Two species of Stentor have also been observed, but never in quantity. *Ceratium longicorne* and *Peridinium tabulatum* are two interesting infusorians found at times in vast quantities. *Trachelocera olor* is another filth infusorian occasionally seen. *Amphileptus anser* is also found usually among decaying vegetation. The other species of infusoria have thus far been found only occasionally. The presence of any considerable amount of infusoria must be taken as indicating serious contamination.

Of fresh water polypes, we have the two common species of hydra, namely, *Hydra vulgaris* and *Hydra viridis*. The natural habitat of the hydra is ponds, ditches, and any slow running and stagnant water. Their food is chiefly the smaller species of entomostraca and infusoria among living animals and probably any small particles of organic matter which may be present. When in confinement they have been known to thrive on shreds of fresh meat. Their presence in any quantity must be taken as indicating a considerable degree of impurity.

Of entozoa we find the common *Anguillula fluviatilis*, and it is supposed that the ova of *Ascaris lumbricoides* have been seen. This worm is the well-known parasite of the human intestine. It is also a parasite of some of the domestic animals, as for instance the hog, and the probability of its presence may be inferred by considering the nature of the contamination about Hemlock lake.

Of the annelida, we have recently identified a few specimens of the disgusting *Tubifex rivulorum*, a reddish transparent worm whose natural habitat is in the banks of mud deposited from flowing sewage. In the eastern part of the city there are several streams whose flow in dry weather is almost

entirely made up of sewage, and in the mud along the margins of these streams Tubifex may be found in vast quantity. The more offensive the stenches arising from the deposited sewage the greater the probability of finding Tubifex. Several times I have seen the mud margins of these streams completely covered for many hundred feet with this unpleasant creature. Their red color enables one to easily distinguish them, and it is an interesting experiment to disturb a colony and observe how quickly they withdraw from observation into the mud. From a histological point of view Tubifex is of the greatest interest, as its transparency is such as admits of a detailed study of the most minute structure of the living worm. 'We may learn all the mysteries of its life, see its two hearts, its large liver, its blood-vessels, its nervous centres, and, indeed, its whole nervous and circulatory system.' Its presence in any quantity could be safely taken as evidence of sewage contamination.

Of the rotifera 20 species are known to exist in Hemlock lake water, and many of them are of interest from every possible point of view.

Plumatella, *Paludicella*, and *Christatella* are the three representatives of the fresh-water polyzoa thus far identified. Our president has made a special study of these animals, and has watched the development of Plumatella from a few individuals to a numerous branching colony, consisting of hundreds. Generally they may be looked for in waters containing decaying matter, and Johnson says of one species, not, however, found in Hemlock lake, that it occurs in stagnant waters, especially such as are tinctured with iron in solution. Their presence in Hemlock lake water must also be taken as indicating at any rate a moderate degree of contamination.

ENTOMOSTRACA.

Fourteen species of entomostraca have been recognized, and several of them are found at different seasons in great quantity. A knowledge of these little animals is of the greatest importance, not only because of their unparalleled numbers, but because of their intimate relation to what may be termed *gross* organic infection. They serve not only as food for many species of fish, but they also serve (being themselves enormous gluttons) as devourers of that which if left in the waters they inhabit would become the source of devastation and death. Referring to this group, C. L. Herrick, the American authority, says:—'The animals of the above group are, it is likely, the best criteria by which to judge of the purity of natural waters, if their distribution were correctly understood. A critical study of the contents of samples of such waters will enable us to determine their character almost as well as by analysis.'

The entomostraca substantially conclude our list of life residing in Hemlock lake, and we may now turn to the protophyta; and among these, as being lowest in the scale, we will first consider the bacteria. Several species have been seen, but whether they belong to the septic or pathogenic forms we have no means of determining. At any rate, the conditions about Hemlock lake are such as to render the presence of pathogenic bacteria at times by no means improbable. The stimulating effect of the dissolved phosphates and nitrates of commercial fertilizers has vast importance in relation to the possibility of the presence in Hemlock water of the pathogenic bacteria. These substances are found to be the natural nutrients for bacterial life, and their presence even in very minute quantity would be liable to lead to serious consequences. A recent editorial in the *Sanitary Engineer* places the argument so appositely in its application to the conditions at Hemlock lake that I will cite the conclusions here. The editor says:—'A dangerous water supply is not merely one which actually contains specific pathogenic bacteria. It is one which is specially liable at times—not always—to contain bacteria. This

liability exists whenever a water supply is contaminated with human excreta, and biological analysis, in the great majority of cases, is simply one means of determining whether such contamination exists. As yet the microscopical section has not undertaken to make the modern culture determination of the number of bacteria present per unit of volume of water. The section, however, has at least two members who are qualified to conduct such examinations, and it is expected that during the present year a series of such cultures will be made, the results of which will in due course be laid before you.

'Of the fresh-water algæ, including the desmids and diatoms, 73 forms are known to exist, and of these 10 classify with the desmids and 39 with the diatoms, leaving 24 which belong with the filamentous and such unicellular forms as are not included with the diatoms and desmids.

'The desmids may be dismissed with a few words. So far as known they have no special significance, being found in water of nearly all degrees of purity. They have never yet been seen in Hemlock water in quantity.

'The diatoms are represented by a large number of species, and many of the species by many individuals. At times a brownish scum is found around the margin of the lake, consisting of innumerable quantities of these little plants. They are not known to be in any degree prejudicial to health, though without doubt they are occasionally the cause of certain bad smells found in various waters.

'Of the fresh-water algæ, the most of them are of the grass-green varieties, and, generally speaking, cannot be considered as possessing any specially deleterious properties. A few species, however, may be noted as an exception to this rule, as for instance, *Conferva bombycina*, is frequently met with as a yellowish-green, cloudy stratum in stagnant water. This alga has narrow thread like filaments with the cells from four to five times as long as broad.

'*Nastoc piscinale*, *Sphærozyga polysperma*, and three species of *Oscillaria*, which have been identified, are of special interest by reason, not only of their possible relation to the bacteria, but because of their having been concerned in serious troubles which various water supplies have experienced at different times. These plants are farther closely related to the anabænas, which are specially liable to give rise to unpleasant odors and tastes when undergoing decay.

'The nostocs are farther of interest in this connection as being the chief source of the unpleasant smell known as the pig-pen odor.

'It is matter of congratulation, therefore, that thus far these species have been seen in Hemlock water, with one exception, in very small quantity. The single exception is an *oscillaria*, present about a year ago in considerable quantity, but which was not at that time, so far as known, the cause of any unsanitary condition of the water.

'This matter of the relation of plant forms to unsanitary conditions is not only of the greatest interest from the sanitary point of view, but it, farther, has important bearings to the student of cryptogamic botany, and certain questions as to mode and period of recurrence may possibly be settled by such a long-continued series of systematic observations as this section has undertaken.

'The above is a fair exhibit of the microscopic fauna of Hemlock lake so far as it has been elucidated up to the present time. By the end of another year we hope to be able to lay before you many facts of interest, of which at the present time the significance has not been made out. Moreover, the conclusions of this paper, so far as we express any, must be considered as somewhat provisional and subject to revision if additional study shall seem to justify the same.'

Several conclusions deduced from the study are stated thus:—

First. That Hemlock lake water as it comes to the city contains not only

the germs of numerous forms of infusorial life, but that it contains the nutrient principle necessary to the development of such forms.

Second. The considerable diversity of forms which are found indicates a corresponding diversity in the quality of the nutrient principle.

Third. The profusion of forms found in dead ends and in mains with inadequate circulation indicates that light is not essential to the development of the lower forms of life.

Fourth. The city water department has been aware for several years that dead ends require frequent flushing, made manifest to the department by frequent complaints from consumers as to the quality of the water at such points. The results of our study may, therefore, stand as justification of the expense of a systematic flushing of mains by that department.

Fifth. The farther conclusion may be drawn not only by the management of our own water-works, but by all engineers engaged in designing and constructing water-works, that thorough circulation is of prime importance, and this work appears to furnish justification of considerable additional expenditure in order to secure thorough circulation in every part of a pipe distribution system.

Sixth. The question of covered versus open reservoirs has been considerably discussed, not only by engineers, but by chemists and biologists, and widely varying opinions have been expressed. The opinion has been generally held, however, that covered reservoirs are necessary to prevent the development of life in standing water, and in England large amounts have been expended in constructing reservoirs with masonry covering. Our study of the development of life in the mains appears to justify the opinion that at present the utility of such expensive constructions is not fully proven.

Concluding this part of the subject your attention is directed to the fact that this work has therefore in addition to its purely scientific aspect a fair proportion of commercial value.

SANITARY CONSIDERATIONS.

The question will at once arise, Are any of the forms now known to exist in the water of Hemlock lake such as really indicate organic impurity, and are they farther such as are prejudicial to the public health? A complete answer to this question would involve tracing the life-history of each and every form, and this cannot at present be done. We have, however, certain known points established from which we may reason to definite conclusions. For instance, certain algæ are known to produce diarrhœal difficulties, and an excessive amount of certain algæ present in a public water supply has been accompanied by an alarming mortality of the fish. Several water supplies have been at times very offensive by reason of the presence of a large amount of sulphureted hydrogen caused by the decomposition of algæ. Again, the presence of nematoid worms and small leeches may give rise to certain grave disorders of the human system which we cannot go into here. There are, however, numerous forms, both animal and vegetable, to which no special effect on health can, at present, be assigned. In any case a knowledge of their existence is important as indicating the presence of organic impurities or as possibly indicating putrefaction, and even though we have as yet no evidence that they are harmful, still we would not hesitate to condemn a water found swarming with any of the lower forms of life.

In thus presenting the present sanitary condition of the water of Hemlock lake, there is no intention of alarming either the members of the Academy or the public. Indeed, we do not consider the contamination as yet great enough to be the cause of any serious alarm. We do think, however, that the gradually increasing contamination which has been shown to exist is a

matter worthy of consideration by every citizen of Rochester. Certainly the building of a railway to Hemlock lake and the making of a public pleasure resort would be in the fullest sense a public calamity, and it cannot be possible that the eminent citizens who have advocated such a road really understand the tendencies of their project. Rochester already has abundant pleasure resorts at Lake Ontario with every facility for unlimited extension in that direction, and in the interest of sound public health it is to be hoped that if additional pleasure roads are required they will be built in the direction of Ontario rather than of Hemlock.

Reports of recent articles.

Snake Poison.—Dr. H. C. Yarrow, of Washington, D. C., has been experimenting with a view to determining the value of certain reputed antidotes to serpent venom. All of them thus far in his hands have proved valueless with the exception of the fluid extract of jaborandi, which seems to possess antidotal powers, at least in the case of mammals, but upon fowls it appears to have no such effect. He has given hypodermically to rabbits fourfold lethal doses of *crotalus* (rattlesnake) venom, and then, by the administration of 35 minims of fluid extract of jaborandi, serious results were prevented. The use of jaborandi as an antidote to venom poison was first suggested by Dr. Tosso, of Paris, in 1882. He reported a case of viper bite cured with an infusion of the leaves.

The Parietal Eye in Fishes.—This is the title of a communication made by Mr. J. Beard to *Nature*. It follows up the researches of Spencer and DeGraaf on the third eye in the lizard (*Hatteria punctata*). *Petromyzon planeri*, *P. marinus* and *Bdellostoma* were the species examined. The conclusive summing up is this :—' From the start of my investigations I was fully convinced that the evolution of all three eyes must be viewed from one common starting-point. The fact that, as Wiedersheim states, even in man nerve-fibres have been traced from the optic thalami to the pineal gland is sufficient evidence for this, even if we did not know that all three eyes arise in connection with the same portion of the brain. The hypothesis is an extension of that given by Wiedersheim, Carrière, Dohrn, and others, to account for the evolution of the paired eyes. The starting-point is a dorsal optic plate before the neural folds begin to form. This gives us a dorsal eye on the so-called invertebrate type. When the neural folds begin to form so as to evolute the brain and spinal cord the optic plate was, of course, being part of the brain, involved in the involution. With the progression of the latter it probably increased in size, and extended somewhat over the lateral margins of the neural folds. When the neural folds close and shut in that which forms the optic vesicles, part of the optic plate was left, forming the rudiment of the parietal eye. This, just as all known sense-organs tend to get involuted, got also secondarily involuted, and that but slowly, so that the outside wall of the involution had time to become a lens, an eye being just formed on the invertebrate type. The parietal eye, being closely bound up with the paired eyes, got secondarily involuted with them ; and losing its primary mode of origin by delay in its development, it now appears as a secondary outgrowth of the brain, in which the lens is still formed from the outer wall. The lens, moreover, possibly retains traces of an involution.'

Parasitic Fungi of Illinois, Part II, Erysipheal.—This is one of the bulletins of the Illinois State Laboratory of Natural History, at Champaign, by T. J. Burrill and F. S. Earle. It treats of the ' white mildews ' or ' blights,' a coating on the leaves of many plants. The general biology of the fungus.

its mode of occurrence, various forms, sexual development, and systematic relations are first treated. Then follows a key to the genera, accompanied by figures and a systematic description of all known species of Illinois.

Alcohol a Food.—Gen. A. W. Greely, in the *Forum*, says:—The subject of alcohol was frequently and generally discussed during the winter at Cape Sabine, and all, without exception, concurred in the opinion that spirits should be taken after a day's labor was over, and not before or during exhausting work, nor while suffering from exposure that was to be continued. Later, when the party had been slowly starving for many months, and when the supply of food was so diminished as to necessitate a greater reduction of rations, the pure alcohol on hand was issued as food, being diluted by about three times its weight of water. Each man received daily perhaps a quarter of an ounce of alcohol, the effect of which was most beneficial. The general impression was that the alcohol supplemented food, and had a decided alimentary value. There could be no question of its beneficial effects as a mental stimulus to every member of the party under the unfortunate conditions at Sabine.

Histology of the muscles of the fly.—B. Thompson Lowne* finds in insects three varieties of striated muscle, two of which differ from the form common in mammalia. Strangely, what would seem the highest form of insect muscle is found in the vermiform larva, and disappears in the imago; and it is like the kind found in mammals, consisting of a number of prismatic columns surrounded by an intercolumnar substance mapping it into the irregular 'fields of Cohnheim.' In the imago two forms distinct from that of the larva may be seen, and have been recognized by Dr. Weismann and M. Viallaines, designated as the ordinary muscles and the muscles of flight. The latter consist of very large columns devoid of an investing sheath. In optical, longitudinal section each fibre is seen to consist of very fine beaded fibrillæ imbedded in a ground substance of low refractive power, in which rows of very small oval nuclei are found. These are unlike other muscles physiologically, their contraction being vibratile, like an artificial incomplete tetanus; that is, a prolonged series of single contractions, with fatigue period of extremely short duration. If the interfibrillar material be nutrient its abundance between the contractile fibres is explained in relation to the physiological properties of the muscle.

The third type, or ordinary muscle of the imago, consists of a single hollow column; the cavity is an axial canal, which encloses a row of nuclei. The fibre has a more or less distinct sarcolemma. It is most like the heart muscle of vertebrates in structure. Physiologically it is not fully understood, but its contractions seem clonic, rather than tetanic; a sharp, sudden, but not sustained, contraction, or powerful single contractions.

The staining of animal and vegetable tissues.†—IV.

By ARTHUR J. DOHERTY,
MANCHESTER, ENGLAND.

STAINING BLOOD CORPUSCLES.

Smear the centre of a glass slip with a drop of freshly-drawn blood from a frog or newt, and add a drop of a saturated aqueous solution of picric acid. In five minutes absord the acid with filtering paper, and flood the slip with picro-carmine (*formula supra*). At the end of an honr, drain off the stain,

* Journ. Quekett Micr. Club, Dec., 1887, p. 182.
† Continued from page 50.

add a drop of glycerin, and cover. Place a clip on the cover, and hold the slip for an instant under a stream of cold water. Dry the slip carefully with a soft linen handkerchief, and give the amount a *thin* ring of zinc white cement. The slide may be now examined under the microscope. The nucleus with its plexus of fibrils is stained red, the peri-nuclear part yellow. On the third, fifth, and seventh days after mounting, ring the slide with gold size, and finally finish off with zinc white. Such a preparation, if not absolutely permanent, will keep for many years without change. The object of first treating the blood with picric acid is to coagulate the contents of the corpuscles; and if osmic acid be used for this purpose, instead of picric acid, and the blood be afterwards stained with picro-carmine, or logwood, the preparation will show colorless corpuscles with their nuclei stained.

PICRO-CARMINE AND LOGWOOD.

This combination may be employed for sections of tongue, skin, striped muscle and many other tissues. Dr. Gibbes states that he has found it 'useful in bringing out the delicate tissue in the tubuli seminiferi of the testis, and showing the developing spermatozoa there.'

Stain the sections for twenty-four hours with picro-carmine and then, without rinsing them, transfer to a weak logwood solution until they assume a violet color; they are then gently washed in water and mounted in glycerin or balsam.

PICRO-CARMINE ROSEIN AND IODINE GREEN.

I have used this combination for some time for staining odontophores, and the result is beautiful in the extreme.

The palate is first stained with picro-carmine for twenty-four hours; it is then transferred for a few minutes to a 1% solution of rosein in rectified spirit; from this it is removed to 90% alcohol, to remove the surplus color, and then it is stained with a 1% alcoholic solution of iodine green. It is next washed in alcohol, cleared in clove oil, and mounted in Canada balsam.

CARMINE, AND INDIGO-CARMINE.

For sections of skin and scalp, this combination is certainly the best I have ever employed.

Stain the sections with carmine, and rinse them rapidly in rectified spirit, acidulated with a little hydrochloric acid; wash all traces of the acid away with spirit, and transfer them to the indigo-carmine solution, which is prepared as follows:—Make a saturated aqueous solution of indigo-carmine or sulpindigotate of soda, and allow it to stand for an hour; then add to it, slowly and gently, about one-third its bulk of rectified spirit; syphon off the mixture from the precipitate and pass it through several folds of fine filtering paper; it is then ready for use. The sections soon stain in this, and should therefore be examined every few minutes to avoid over staining; when ready they are rinsed in 60% of alcohol, dehydrated, cleared in clove oil, and mounted in balsam.

LOGWOOD AND EOSIN.

This is a beautiful combination for cartilage and the cerebellum. The sections are first stained with logwood, and are then washed; they are next stained for about one minute with a strong solution of eosin (I prefer an alcoholic solution for this purpose), and are finally washed in rectified spirit, dehydrated, cleared and mounted in Canada balsam.

PICRO-CARMINE AND IODINE GREEN.

This combination may be employed for sections of tongue, stomach, and œsophagus. Stain the sections first with picro-carmine, and wash them in

water acidulated with a few drops of acetic or hydrochloric acid; then transfer them for about one minute to a strong aqueous solution of iodine green; wash them in rectified spirit, and mount in the usual manner.

CHLORIDE OF GOLD, ROSEIN, AND IODINE GREEN.

This is a most beautiful combination for preparations containing growing bone; but it is one which requires great care, and a certain degree of skill in the use of staining reagents to employ satisfactorily. The staining is well shown in the tail of a young rat or mouse.

Cut off the tail of an etherised rat or mouse, and divide it into pieces an inch long; place them in a 1% solution of gold chloride for one hour, and then transfer them to a mixture composed of 40 cc. and 10 cc. formic acid. Keep the bottle in the dark. In from eighteen to twenty-four hours the gold will be completely reduced, and the lime-salts removed from the bone. Harden the pieces of tail in strong rectified spirit for three weeks, changing the spirit at the end of the first hour, the first, third, and seventh days. Make sections with the freezing microtome, and stain them, first with an aqueous solution of iodine green, and then with an alcoholic solution of rosein. Mount in Canada balsam.

The gold will be found principally on the skin and tendon cells, the anilines on the underlying tissues.

Very many combinations, besides those which I have described, will be discovered by an experimenter in this art, but it is doubtful whether any discoveries in this direction will bring to light new facts connected with histology; still, improvements on present methods might be hit upon, and would be welcomed by microtomists.

Beginnners in staining should, as in every other art, follow out directions strictly; they will then learn the reason, the *chemistry* of each operation, and, after this, will be able to alter or modify processes to suit special cases, or to extend the application of those processes to fresh branches of work.

EDITORIAL.

We desire to call particular attention to the method for imbedding vegetable tissues in paraffin, described in another portion of this JOURNAL from the original paper in the *Botanical Gazette*. Upon perusing the original, we were at once convinced that Dr. Moll had found a valuable method. We have since had the good fortune to receive from Prof. C. R. Barnes, of Madison, Wisconsin, a slide with several sections prepared after the plan suggested by Moll. If we might venture any suggestion of a possible improvement upon the method, it would be that the staining should precede the cutting of the sections and not follow it. This would present no difficulty so far as we can see. The vital point in the discovery is in the mode of preserving the tissues for cutting. Subsequent to that the tissues can doubtless be subjected to the same treatment as animal tissues. The value of the process scarcely calls for comment with those who understand what serial section-cutting is to zoölogy.

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Science in Australasia.—We only think of our own country as the one where wonderful progress has taken place. The people of San Francisco, Denver, Chicago, St. Paul and other cities of beauty and progress are proud to compare the present with a couple of decades ago—and with reason. But the antipodes are also doing the same. In Australia, New Zealand and other outposts of British colonization progress has been the rule. This is forcibly presented in the English journal of scientific news—*Nature*. We have no such American journal to which we can turn to know what scientists are do-

ing the world over. In *Nature*, lately, are notices of the nineteenth volume of the Transactions and Proceedings of the New Zealand Institute (Wellington, May, 1887). In the contents upwards of 50 articles are named :—Zoölogical, Botanical and Geological. Some of these are descriptions of new species, others anatomical or histological, indicating a commendable scientific activity. The report of the colonial Museum and Laboratory of New Zealand for 1886–'87 is the 22d Annual Report. The total number of additions to collections during the year have been 10,708. Analyses made, 345, as follows :—Coals and oils, 22 ; rocks and minerals, 117 ; metals and ores, 43 ; examinations for gold and silver, 81 ; waters, 36 ; miscellaneous, 46. We noticed in the last volume of this *Journal*, p. 199, a similar report from New South Wales. Frequent articles from professors in the schools of these far-distant lands, and other indications, point to a scientific interest and progress there not equaled in our country except at a few of our warmest foci of scientific activity. Our ideas of those countries are, probably, as inadequate as the ideas entertained by our English neighbors of our own country ; we should, probably, not go far astray if we were to think of the cities and towns of Australia, New Zealand, etc., as being as comfortable in all the necessaries of the present civilization as we are ourselves. In that country, as in our own West, the past two decades must have meant a period of marvelous growth. A reflection on the important part which a scientific knowledge of the conditions of life has played in making possible this wonderful advance both in America and on the other side of the globe is not out of place, but need only be mentioned now.

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Editor's Address.—During the entire months of June, July, and August the Editor will be disengaged from his duties as professor in Hamline University, and letters will reach him more promptly if addressed to No. 3 East 47th street, New York city.

NOTES.

Forced respiration.—A most surprising case is recorded by Dr. G. E. Fell, of Buffalo, N. Y. A man had taken an overdose of laudanum and chloral about 10 P. M. on Saturday. At midnight his wife noticed heavy breathing, and summoned physicians. Dr. Fell took charge of the case. Artificial and forced respiration was begun. The next morning at 6.45 it was found that the respiratory centre was entirely paralyzed, and on cessation of the forced respiration he could make some voluntary breathing movements, but breathing could not proceed automatically. The bellows continued to be used until the following day (Monday) at 9 A. M., when the tracheotomy tube was removed, and the patient has since recovered.

Marshall D. Ewell, M. D., LL. D., author of 'Medical Jurisprudence,' has been engaged by the law school of Cornell University to deliver a course of lectures upon that topic during the season of 1888–'89.

MICROSCOPICAL SOCIETIES.

The American Society of Microscopists.—T. J. Burrill, *Secy.*

The annual meeting will be held at Columbus, Ohio, August 14–17, 1888. The invitation comes from the young and vigorous State Microscopical Society of Ohio, Dr. H. J. Detmers, president. There has been quite a contest between our friends in three cities over this meeting, and the final vote of the executive committee has just been taken. There is great local interest, and every needful thing to facilitate work, as well as a hearty welcome, and pleasant entertainment may be expected. The society will doubtless accept the cordial invitation by a large attendance and a good programme.

The location is convenient, accessible, and within easy reach of Cleveland, where the American Association for the Advancement of Science meets the succeeding week.

President Kellicott has appointed an efficient and enterprising committee on working session. These gentlemen have accepted the appointment. This insures the success of an important part of the programme, though of course the hearty aid of the members is expected.

CHAMPAIGN, ILL., *March 8, 1888.*

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WASHINGTON, D. C.—E. A. BALLOCH, *Secy.*

At the 72d meeting Mr. F. T. Chapman read a paper on soap-bubble films. It will appear in our May number (p. 81).

Prof. Seaman showed a lamp and vertical illuminator. He said :—'You may remember that some time ago I showed a vertical illuminator made by Mr. Chas. Fasoldt, of Albany. I have here a slide of his rulings which contains nineteen bands, from 5,000 to 120,000 to the inch, which is no doubt a very excellent specimen of this kind of work similar to the celebrated Nobert plates. I have no hesitation in saying that on an object of this kind with an immersion lens the definition obtained by this illuminator is superior to anything I have ever seen, and that by its means the human vision may be pushed to its utmost limit.'

NOTICES OF BOOKS.

A Course of Elementary Instruction in Practical Biology. By T. H. Huxley and H. N. Martin. Revised edition by G. B. Howes and D. H. Scott. London and New York. Macmillan & Co. 1888. pp. 512.

There is probably no text-book which has done so much to turn the course of study in a direction both new and most fruitful of good results as Huxley & Martin's Practical Biology, first published in 1875. It is the first of a very large number of practical guides which have now largely replaced the older text-books—those in which the facts were stated in a direct narrative, and of which Gray's First Lessons in Botany is a good example. The purpose of this newer method has been to lead the student to work out the knowledge for himself. By giving him a series of separate but definite tasks or directions he is kept constantly upon the subject in hand, and great benefit is secured thereby. He knows exactly what he is to do, and he either succeeds or he fails. The value of this method has been fully tested, and the many works which have appeared since and have applied the plan in various departments show how perfectly it meets the needs of the day. Important as was the benefit conferred on teachers by Huxley's Practical Biology in its *method*, it was still more valuable for the *subject-matter* which was brought to light and impressed upon the user. It marks the beginning of a new era in studies upon living organisms—an era where the study of isolated parts was largely discontinued and the organism began to be studied in its entirety. In this regard it seems to us that the Practical Biology is far superior to most of the later works which have been designed to partially or wholly supplant it. The days for studying bones or lingual ribbons or scales or any other isolated parts are being deferred. Classification, which should be the latest step in true science, is ceasing to be studied first, and biological study is beginning to mean the investigation of form, structure, and function. The best thing about this book is the extent to which it keeps physiology in sight. We should be glad if it did so more. In so far as the student is kept to a notion of any organism as a whole body, though he may not of course take up all the details, he gets a view of a living unit, and not of a fragment. Biologists should insist upon this as the minimum in a course of study on any organism. Later as many forms or as much detail may be studied as time permits. Of course we are not to be understood as meaning here that such must be the course in primary instruction or in the use of the microscope merely as a means of amusement. In the latter case studies upon morphological topics are often most useful.

The revision and extension which has now appeared adopts the same excellent plan of treatment as its predecessor, but differs from it in these particulars, first, the arrangement of the matter, and second, the number of types studied. There are also some changes in the descriptions of the old forms. The change in order of studies was found advisable by Professor Huxley shortly after he had put the book into his classes, because of the difficulties encountered in the minute forms involving often the handling of the microscope, and so the acquirement of a 'new sense.' The

order now is from a vertebrate animal to a protozoan; then from yeast to a flowering plant. The number of types has received several additions, and the following is the list, those added being printed in italics:—Frog, Crayfish, Lobster, *Earthworm*, *Common Snail*, Fresh-water Mussel, Hydra, Bell Animalcule, Amœba, Yeast, Protococcus, *Spirogyra*, Bacteria, Moulds, Charce, Pteris, Bean plant. The addition of the Earthworm and Spirogyra are especially to be commended, and the gastropod is also very welcome. The value of the earthworm for biological instruction has been recognized by Sedgwick and Wilson. It has been made the object of their most charming book to give one an introduction to animal life. The additions to the old types are in the application of new discoveries in methods, and especially the study of the embryology of the animal types taken. On the subject of the frog 12 pages are added.

Professor Huxley has added a preface to the new edition in which, concerning the practical benefit of even a three or four months course in Biology, he very justly says that it gives the medical student such a practical knowledge of the elements of anatomy, histology, embryology, and physiology as otherwise is not gained at all or only at the expense of much precious time. The new book contains nearly twice as many pages as the old one; an appendix with many valuable technical suggestions. Like the former work it is not illustrated.—O.

Annual Report of the State Geologist of New Jersey for the year 1887. By G. H. Cook. Trenton. pp. 45. 1 map.

The principal work of the survey during the past year has been devoted to the making of a map of New Jersey—a work which has been in progress for some time. Besides this, some field work has been done, chiefly in the study of archæan rocks in the northern part of the State. The report is accompanied by a topographical map of the State on the scale of 5 miles to the inch. One of the most important practical problems before the survey is to provide a proper water supply for the great cities, especially Newark and Jersey City. These are now supplied from the Passaic river at Belleville, where the water is contaminated by the salt water and by the sewerage of Newark. In pursuance of this object a relief map has been constructed on a scale of 5 miles to the inch. It is demonstrated that an abundant supply can be had about the mountainous head-waters of the Passaic, and that this can be delivered to the cities by the force of gravity alone from a distance of only 20 miles.—O.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, an material for mounting.]

WANTED.—Parasites and books on Parasites and other micro. subjects. Will give Anatomical, Pathologil cal, Botanical, Micro-fungi, Zoophytes, Polycistinæ, Foraminifera, Parasites, and other slides in return.
FRED. LEE CARTER, Gosforth, near Newcastle-on-Tyne, England.

Wanted, Diatomaceous earth from Mégillanes, Bolivia, South America. Can give in exchange either Diatomaceous earth from New Zealand or cash. E. MICHALEK,
I. Fleischemarkt, No. 1, Vienna, Austria.

Mounted sections of Fœtal Lung (5 months), sections across entire lobe, $\frac{1}{1000}$ in. thick, beautifully stained, in exchange for first-class pathological slides. W. C. BORDEN, M. D., U. S. A.,
Fort Douglas, Utah.

Correspondence relative to exchange in microscopical material or prepared mounts.
HENRY L. OSBORN, Hamline, Minn.

Wanted, earths, recent diatoms, and miscellaneous objects for mounting. Only first-class material offered or desired. MARY A. BOOTH, Longmeadow, Mass.

Fossil Diatomaceous deposits (marine) wanted from Bermuda, Virginia, Maryland, California, etc.
I. ELLIOTT, Ardwyn Villa, Aberystwith, Wales, England.

Labels for slides. EUGENE PINCKNEY, Dixon, Ill.

Notices.—All communications for publication should be addressed to Henry Leslie Osborn, Hamline University, Hamline, Minn.

Subscriptions, and all matters of business, should be addressed to the Manager, Chas. W. Smiley, P. O. Box 630, Washington, D. C.

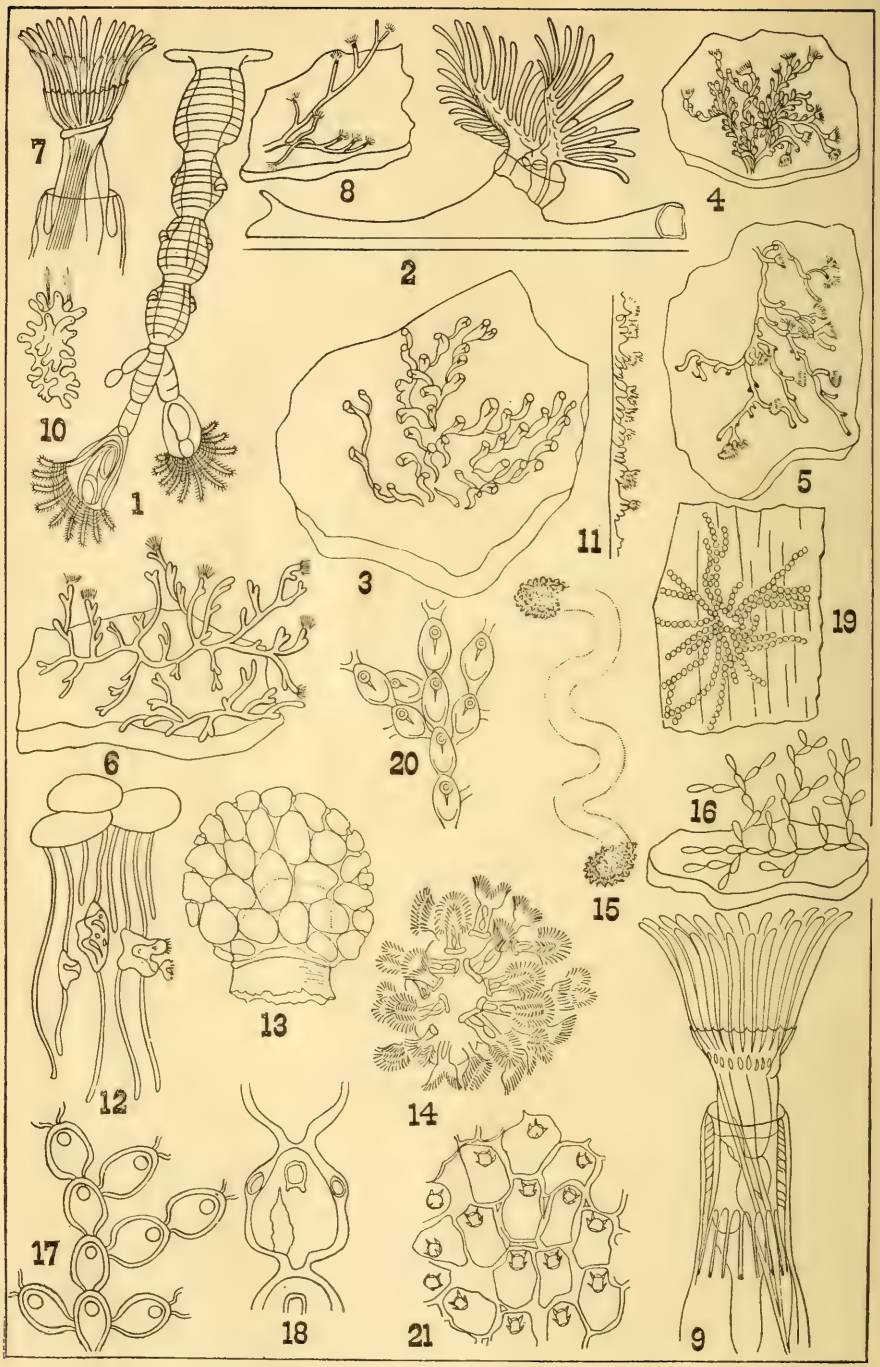
Subscription price $1.00 PER YEAR *strictly in advance. All subscriptions should end with the December number.* A pink wrapper indicates that the subscription has expired. A date on the wrapper indicates the month to which payment has been made.

Orders for slides advertised by A. J. Doherty in the Journals from January to April, 1887, may be sent through the Business Manager, P. O. Box 630, Washington, D. C.

A few copies of Leidy's Fresh-Water Rhizopods, of North America, can still be had at $5.00 per copy.—P O. Box 630, Washington, D. C.

Remittances should be made by postal notes, money orders, or by money sent in registered letters. Drafts should be made payable in Washington, New York, Boston, or Philadelphia, to the order of the Manager.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the following prices which are net:—Vol. II (1881) complete, $1.50; Vol. III (1882), out of print; Vol. IV (1883) complete, $1.50; Vol. V (1884) complete, $1.50; Vol. V (1884), Nos. 2-12, $1.00; Vol. VI (1885), $1.50; Vol. VII (1886), $1.00; Vol. VIII (1887), $1.00. As calls for Volume I sometimes occur, those persons having copies to dispose of would do well to inform us, and to state their prices.



FRESH-WATER POLYZOA.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. IX. JUNE, 1888. No. 6.

Analytical Key to the Fresh-water Polyzoa.*

The Polyzoa are so plentiful in our ponds and slow streams, and so exquisitely beautiful, that those who are lovers of nature, although not professional naturalists, should be more familiar with them than the majority of such people seem to be. The amateur microscopist, or the advanced one indeed, can find no more attractive field for investigation than that occupied by the fresh-water Polyzoa. They abound almost everywhere in our ponds and lakes. They encrust the lower surfaces of the stones, the floating log, the lily stems; they cling to the rootlets of *Lemna*, and even form huge, slightly adherent, or often floating, masses of jelly, into which the charming animals retreat at the least alarm, and from which they spread their lovely plumes when they feel that all is well. They are, therefore, easily obtained. 'It is the first step that costs,' and here the first cost to the beginner consists in learning to recognize the colonies with the naked eye.

The jelly-forming *Pectinatella* produces gelatinous masses, varying with age from the size of a pea to that of a man's head, or larger; the color being pale reddish or a flesh tint. The masses are adherent to almost any submerged object in still water, becoming easily detached when old, and then often floating just below the surface. When in this condition, the colonies frequently contain many scattered white spots, quite visible to the naked eye. The beautiful animals secreting and living within this gelatinous aggregation can be seen only with a good pocket lens; to properly examine them a compound microscope is needed. This also holds good in reference to those forms which encrust submerged objects with their tubular colonies; a microscope and some patient care being needed, for the little creatures are timid. Once

EXPLANATION OF PLATE.

FIG. 1.—*Urnatella gracilis*. After Leidy. Slightly altered.
2.—*Plumatella repens*. After Jullien.
3.—*Plumatella lucifuga*. After Jullien, from Hancock. Slightly enlarged
4.—*Plumatella arethusa*. After Jullien, from Hyatt. Life size.
5.—*Plumatella diffusa*. After Jullien, from Hyatt. Life size.
6.—*Fredericella sultana* (*Plumatella lucifuga*). After Jullien, from Allman. Life size.
7.—*Fredericella sultana* (*Plumatella lucifuga*). After Jullien, from Allman.
8.—*Fredericella regina*. After Jullien, from Hyatt Life size.
9.—*Fredericella regina*. After Jullien, from Hyatt.
10.—*Hyalinella vesicularis*. After Jullien, from Hyatt.
11.—*Hyalinella vitrea*. After Jullien, from Hyatt. Life size.
FIG. 12.—*Lophopus Trembleyi*. After Jullien, from Allman. Life size.
13.—*Pectinatella magnifica*. Outlines of a colony, reduced in size. After Jullien, from Hyatt.
14.—*Pectinatella magnifica*. Young colony, enlarged. After Hyatt.
15.—*Cristatella ophidioidea*. After Jullien, from Hyatt. Reduced in size.
16.—*Paludicella Ehrenbergii*. After Jullien, from Allman. Life size.
17.—*Norodonia Cambodgiensis*. After Jullien. Colony, enlarged.
18.—*Norodonia Cambodgiensis*. Cell enlarged.
19.—*Norodonia Sinensis*. After Jullien. Colony, enlarged.
20.—*N. Sinensis*. After Jullien. Cells enlarged.
21.—*Hislopia lacustris*. After Jullien, from Carter. Colony, enlarged.

* From the *Journal of the Trenton Natural History Society*, January, 1887. See Frontispiece.

frightened into their protective cells, they are usually slow to show themselves again; but a sight of their graceful plumes is worth waiting for.

The colonies of tube-forming Polyzoa are visible to the unaided vision as brownish, chitinous, thread-like objects, adherent to the lower surfaces of stones and other submerged substances, for most of them shun the light. These thread-like, often branching, tubules are quite firm to the touch, and they are sometimes dislodged from their support with difficulty. To collect them, it is usually best to take stone and all, or to remove them with a large slice of the wood; if then placed in a watch-glass, on the stage of the microscope, in water of course, the enclosed animals will sooner or later expand their plumes and amply reward the patient watcher.

About the only portion of the animal, or polyp, usually extended beyond the cell which it secretes and inhabits, is that part named the lophophore, on which are the long, flexible and peculiarly graceful tentacles. This lophophore may be shaped like a horse-shoe, it may be oval, or circular. The tentacles are always entirely ciliated, and vary greatly in number in the various species.

Reproduction takes place by budding, and by the formation of statoblasts, or the so-called 'winter eggs.' These are oval, brownish bodies, quite visible to the unaided vision, when seen under favorable circumstances. They are formed in the autumn, leaving the animal only when the latter dies, and the soft body melts away in the water. The softening masses of Pectinatella are often to be found in the fall, densely studded with these reddish-brown statoblasts, the margins of the latter, in this case, being bordered by a row of doubly-barbed hooks. These statoblasts remain unchanged until spring, when each one then produces an embryo, which finally develops into a polyp.

The following analytical key to the known species of fresh-water Polyzoa is based almost exclusively on Dr. J. Jullien's 'Monographie des Bryozoaires d'Eau Douce,' originally published in the Bulletin de la Societie Zoölogique de France, t. X, 1885. In this country, the only papers on the subject, easily accessible to the student, are Dr. Leidy's contributions to the Academy of Natural Sciences of Philadelphia, and Prof. A. Hyatt's 'Observations on Polyzoa, Sub-order Phylactolæmata,' where many anatomical details may be found.

Key to Genera.

§ Colonies formed of chitinous cells (*a*).
§ Colonies formed of gelatinous tubular cells (*b*).
§ Colonies a jelly-mass surrounding the polyps (*c*).
a. Cells urn-shaped; lophophore subcircular; colonies pendent, . *Urnatella*, 1.
a. Cells tubular; lophophore horse-shoe shaped, ... *Plumatella*, 2.
a. Cells tubular; lophophore circular or oval, ... *Fredericella*, 3.
a. Cells clavate, growing end to end; lophophore circular, . . *Paludicella*, 8.
a. Cells cordate; lateral walls thick; centre thin; colonies linear, prostrate, branching, *Norodonia*, 9.
a. Cells subcircular, flat; sides thick; front thin, transparent; colonies prostrate, usually indefinite, ... *Hislopia*, 10.
b. Branches not attached; lophophore horse-shoe shaped, . . . *Hyalinella*, 4.
c. Colonies more or less globular, permanently fixed (*d*).
c. Colonies oval or elongate, flattened, slowly traveling, . . . *Cristatella*, 7.
d. Colonies sacciform, finally lobed or branched; statoblasts not spinous, *Lophopus*, 5.
d. Colonies globular, orifices grouped in lobed areolæ; statoblasts marginally spinous, *Pectinatella*, 6.

Description of Species.

1. *Urnatella*.

Colonies flexible, $\frac{1}{8}$ to $\frac{1}{4}$ in. long, branching; cells centrally translucent, pale, brown-lined transversely and spotted, ends black, opaque, a cup-like

process on each side; axis a cylindrical cord; polyp bell-shaped, mouth oblique, tentacles 12–16. Habitat, running water. *U. gracilis*, Leidy. Fig. 1.

2. *Plumatella.*

1. Colonies filiform, branching, prostrate or tufted; tentacles 40 to 50; cells subclavate, triangular or subcylindrical in transverse section. *P. repens*, Leidy. Fig. 2.

2. Colonies prostrate and branched, or erect and dendroid; cells tubular, increasing in diameter toward the free end, always triangular in transverse section. *P. lucifuga*, Vaucher. Figs. 3, 6, 7. (Dr. Jullien identifies *Fredericella sultana* with this.)

3. Cells distinct, brown, tough; branches adherent or not, often colorless; colonies dense or diffuse; tentacles 40 to 60. *P. arethusa*, Hyatt. Fig. 4, life size. (Dr. Jullien doubtfully identifies *Fredericella regina* with this.)

4. Colonies prostrate and adherent only; ends of the branches yellowish or hyaline; cells urceolate near the deeply emarginate orifice; tentacles 42; lophophore reniform. *P. diffusa*, Leidy. Fig. 5, natural size. (Dr. Jullien doubtfully identifies *Fredericella Walcottii* with this.)

5. Cells striate longitudinally, the extremity annulate. *P. lineata*, Parfitt.

6. Cells spatulate, prostrate, entirely adherent, orifice in the centre of the enlargement. *P. limnas*, Parfitt.

(Dr. Jullien identifies Nos. 5 and 6 with *P. repens*.)

3. *Fredericella.*

Lophophore oval; colonies attached, dendritic; cells elongated. (This, according to Jullien, is a variety of Plumatella, or rather an arrested development of the latter.) For the following the writer is indebted to Hyatt's 'Polyzoa:'—

1. Main branches closely adherent, forming long single stems, often crossing, the angles acute, the free cells or branches rising abruptly; colonies covering large areas. *F. Walcottii*, Hyatt.

2. Branches colorless, usually entirely adherent, the free parts of the cells occasionally branching; colonies radiating. *F. pulcherrima*, Hyatt.

3. Colonies very variable in form, tentacles 18 to 22. *Var. a.* Colonies not large, branches numerous; attached parts of the cells very long, the free portions mere nubs on the branches. *Var. b.* Main branches not necessarily adherent, but growing in clumps, the colony often attached only by a part of a branch, the free portions of the cells long, on wide surfaces. *Var. c.* Growth dense, branches crowded, sometimes adherent; found only on limited surfaces of small twigs; colonies sometimes 1 to 2 inches deep by 3 to 4 long. *F. regina*, Leidy. Figs. 8, 9.

4. *Hyalinella.*

1. Colonies colorless hyaline, or brown transparent, radiating, branching, prostrate, the branches not adherent; cells about $\frac{1}{25}$ inch long and wide, slightly dilated. *H. vesicularis* (Leidy), Jullien. Fig. 10, natural size. (Dr. Jullien thinks this and Leidy's *Plumatella vesicularis* are the same; he also doubtfully identifies *Fredericella pulcherrima* with this.)

2. Colonies radiating or linear, the thick, colorless gelatinoid cells more or less projecting. *H. vitrea* (Hyatt), Jullien. Fig. 11, natural size. (Dr. Jullien thinks this is Hyatt's *Plumatella vitrea*.)

5. *Lophopus.*

Colonies $\frac{1}{10}$ to $\frac{1}{2}$ inch in diameter, usually branched; tentacles 40 to 50. *L. Trembleyi*, Jullien. (This has not yet been found in the United States.) Fig. 12, natural size, attached to rootlets of *Lemna*.

6. *Pectinatella.*

1. Colonies $\frac{1}{2}$ inch to a foot or more in diameter; tentacles 50 to 80; stomach yellowish-brown, longitudinally plicate. *P. magnifica*, Leidy. Figs. 13, 14.

2. Colonies and animal unknown; statoblast oval, with 14 spines on each end, their free extremities barbed with several recurved hooks. Habitat, ponds near Bombay. *P. Carteri*, Hyatt.

7. *Cristatella.*

1. Colony oval, convex above, flat beneath, yellowish-brown, 2 inches long, $\frac{1}{8}$ inch wide; most motile when young; cells forming 3 concentric rows, on the upper surface; tentacles 30 to 80; polyp yellowish-brown; intestine pale blue-green; contractile disk inferior, oval, very changeable in shape. *C. mucedo*, Cuvier.

2. Colony oval, flattened, yellowish-white or amber, transparent, 1 to 2 inches long, $\frac{1}{5}$ inch wide; traveling about one inch a day; cells in 3 rows; tentacles 62 to 72. *C. Idæ*, Leidy.

3. Colony rounded when young, ribbon-like when old, 5 to 6 inches long, $\frac{1}{4}$ inch wide, $\frac{1}{8}$ inch thick; a colony one inch long travels its own length in one day; cells in from 4 to 8 concentric rows; tentacles about 90. *C. ophidioidea*, Hyatt. Fig. 15, reduced in size.

4. Colony vermiform, very slightly adherent, about 6 inches long, more or less sinuous or spiral; cells slightly projecting, scattered; tentacles 52 to 60, longer than the body. *C. lacustris*, Potts.

8. *Paludicella.*

1. Cells clavate, end to end; tentacles 16; colonies linear, brown, prostrate, and bearing numerous erect branches disposed in little clusters. *P. Ehrenbergii*, Van Beneden. Fig. 16.

2. Cells irregularly disposed, more or less united together, the orifices terminating long, free tubes, exceeding $\frac{1}{15}$ inch; colonies prostrate, the orifices making them bristly, like a chestnut-burr; tentacles 19 to 21. *P. erecta*, Potts.

9. *Norodonia.*

1. Cells cordate, short, thick, slightly pedunculate, largest at base; orifice subquadrangular; lateral walls thick and continuous about the circumference; central area thin, smooth; colonies dark brown, branching; the dried central area glistening like the trail of a slug; cells about $\frac{1}{30}$ inch long. Habitat, Siam. *N. Cambodgiensis*. Jullien. Figs. 17, 18.

2. Cells elongate-cordate, flattened, centrally enlarged, pedunculate, the extremities tapering, especially the anterior; orifice rounded or oblong; lateral and posterior walls thick, the anterior thin; central area thin, a tapering elevation extending posteriorly from the orifice; colonies pale, branching; cells about $\frac{1}{25}$ inch long. Habitat, China. *N. Sinensis*, Jullien. Figs. 19, 20.

10. *Hislopia.*

Cells irregularly oval, prostrate, flattened, anteriorly thin and transparent; lateral walls thick, with 2 to 4 stoloniferous orifices; colonies sometimes linear, oftener indefinite; orifices subquadrangular, a spine at each angle; tentacles 16 (?). Habitat, central India. *H. lucustris*, Carter. Fig. 21.

Trenton, New Jersey.

Drawings v. Photographs.

By Dr. GEORGE A. PIERSOL.

At the present time when, to almost every microscope, a photographic camera is being attached, and when photomicrographs, of every degree of merit, are being produced on all sides, it may be well to weigh the respective values of the pencil and sunbeam as means of recording the observations of the investigator. The idea of reproducing, by photography, what is seen in the microscope, is so captivating that it is a matter for little surprise that so many undertake the work. These remarks do not apply to the photographing of preparations for the purpose of producing excellent pictures, but bear upon the merits of the two methods as auxiliaries to the work-table. That the pencil is being unwisely neglected, owing to a too implicit reliance on photography, is an unfortunate present tendency—especially for the young investigator, who loses the training to accurate observation which the conscientious use of the pencil brings. But both the photographic camera and the drawing-prism have their advantages, and the investigator can afford to dispense with neither, as, by their judicious employment—sometimes by their combination—more satisfactory and valuable results are obtained than are possible by any exclusive adherence to either.

An experience in photomicrography, which warrants a full appreciation of its value and capability, has taught that the most serviceable and satisfactory field of photography lies at the extremes of the table of amplification—with very low (20 to 70 diam.), and with very high powers (500 to 1500 diam.) What drawing can equal, in beauty of detail, a really good photograph of a suitable specimen taken with a fine low power objective; who can draw fibrillæ of striated muscle, a group of bacteria, or a delicately marked diatom in competition with photographs? Excellent pictures are made under ordinary magnifications (200 to 350 diam.), but in the majority of cases there is much less cause for congratulation. Under these circumstances, the conscientiously and skilfully used pencil will produce a more valuable and satisfactory record for the investigator than the camera. The reason that *good* photographs, with very low or very high powers, are so satisfactory is, that under both conditions suitable lenses reproduce *all* the planes of tissue necessary for a serviceable representation of the object; nine times in ten this will not be the case with the pictures demanded of the $\frac{1}{4}$ or $\frac{1}{6}$. While it is unreasonable to expect the lens to reproduce more than the plane accurately in focus, it is nevertheless true that this physical limitation (reduced to a minimum by the thinnest possible sections) frequently renders photographs, under medium powers, unsatisfactory substitutes for more diagrammatic drawings.

At the present time, the investigator who depends upon photographs for his illustrations finds himself confronted by the pertinent question as to the manner in which his pictures shall serve as journal illustrations. That photography, in its applications to book-making, is yet in its infancy, no one doubts; that really beautiful results are already accomplished by the best methods is equally certain: if, therefore, the liberality of the publisher places one of the unexceptional 'processes' at his command, the investigator may feel confident. Let him, however, be cautious as to where he places his hopes when economy is consulted, for there is nothing more annoying to the worker himself, or more unfortunate for the cause of photomicrography, than the dissemination of those monstrosities whose harsh black and white masses, devoid of half-tone and detail, are supposed to 'reproduce' a really fine negative.

Frequently, however, the use of the photograph is out of the question, and the investigator, or the artist, must make the necessary substitute; by all

means let it be the microscopist himself, for he will then have the guarantee that the feature of the drawing, especially valuable, is appreciated. Under such circumstances, a combination of the camera and pencil, which the writer has employed since the introduction of the Eastman 'Bromide Paper,' may often be found very satisfactory. Selecting the 'B' grade, and marking out all undesired parts of the negative, a somewhat under-exposed print is made and developed until the cardinal parts of the picture are visible; this, when dried, yields a black and white sketch which, after being worked over with India ink and hard lead-pencil, presents the appearance of an elaborately finished drawing and, as such, will be satisfactorily copied by the artist on the block or stone. Where details are very simple, the outlines of the photograph are easily transferred to the drawing-paper by means of the interposed sheet of 'graphite' or 'carbon' paper and the tracing point.

But, after all, for the busy worker the direct sketch on paper is frequently the most convenient and economical. It is to be regretted that the drawing-prisms in use on the Continent are not more generally used among our own microscopists. An experience embracing all the usual forms has resulted in a settling down to the Abbe apparatus as being the most satisfactory, and, due regard to the inclination of the mirror and the warranted size of the sketch being observed, as leaving little to be desired. After a long observation of struggles with the drawing-prisms usually furnished by American and English makers, it is truly refreshing to see with what ease and accuracy complicated contours are followed with this instrument even at the first attempt.

With any form of drawing attachment, the nice balance between the illumination of the microscopical image and that of the paper is an all important condition; having had occasion recently to use the Abbe prism to sketch some 1400 sections, a simple device of great service was found. This consisted of a light stand supporting a small glass plate (10 × 15 cm.), two-thirds of which was 'matt,' being very finely ground, leaving the remaining third as a clear strip extending in the direction of the greatest length of the plate. The section being well lighted and focused, and the paper adjusted for the drawing, the screen should be interposed between the source of illumination and the microscope mirror when the object becomes illuminated by a soft diffuse light, very favorable for the rapid and accurate sketching of details. Slight lateral movements of the screen by the left hand soon determine its best position. When a doubt arises as to some detail, a movement of the wrist floods the field with light, enabling an exact observation to be made, while a second change restores the mellow illumination so favorable for drawing. All this can be done without moving the eye from the tube or taking the pencil from the paper. The position of the screen between the light and mirror is more effective than when the ground glass is mounted as part of the substage apparatus. Those who have never used this simple contrivance in drawing will find it a material aid in many cases. Its frequent usefulness on other occasions, as a light-moderator for low power examinations, will insure it a permanent place on the work-table.

WÜRZBURG, GERMANY, *March*, 1888.

Solution of Carmine in Sodium Carbonate.* G. Cuccati.—Sodium carbonate 20 gms., water 100 c.c., heat and add pulverized carmine 5 gms.; then boil, and after the solution has become cold add 30 c.c. of alcohol. Allow the mixture to stand for twenty-four hours, filter and add, little by little, 300 c.c. of water acidulated with 8 c.c. of a 2 per cent. solution of hydric acetate, then 20 gms. of chloral hydrate. After staining, the sections are decolorized in a 1 per cent. solution of hydric chloride in alcohol.

* 3 f. w. Mikros., iv. p. 50, 1887.

Diatoms of Atlantic City and Vicinity.*

By C. HENRY KAIN,
PHILADELPHIA, PA.

There is a popular belief that it is quite useless to attempt to collect diatoms in the winter, and while this is mainly true as regards fresh-water species, it is not so with the marine forms. The only fresh-water species that the writer ever collected in abundance during the winter was *Meridion circulare*, which was gathered from under the ice in January; but some marine species may be found in greater abundance during the winter months than at any other time. In order to know a locality thoroughly, however, it should be inspected both in summer and in winter.

The visitor to Atlantic City who is hunting diatoms may always be gratified by taking the street cars and riding to the inlet. Two or three hundred yards before reaching the terminus of the road a number of large brackish pools may be observed on the meadows just south of the railway. These pools are quite shallow, and are prolific collecting-grounds at all seasons of the year. If a day be chosen when the sun shines brightly, the surface of the mud is coated a rich brown by the myriads of diatoms which rise to the light, and, if a gentle wind is blowing, the scum which is driven to the far shore by the wind is often composed entirely of diatoms without admixture of sand. On Christmas Day, 1886, I collected in this way a very pure lot of *Nitzschia epithemioides*, and in another pool only a few yards away an equally pure gathering of *Navicula veneta*. Sometimes very bright brown patches of diatoms cover the surface of the mud, and the collector, in his anxiety to secure a large gathering, is tempted to collect mud and all with the expectation of separating the diatoms from the mud by washing and whirling. The following plan will be found much better:—Half fill a bottle with water; touch one of these brown patches lightly with the tip of the finger, and the diatoms will adhere; then place the finger over the mouth of the bottle and shake; the diatoms are of course washed off and remain. By repeating this process again and again the water finally becomes quite brown. By the time the collector reaches home the diatoms will have settled to the bottom, and the water may be poured off and the diatoms cleaned. It is worth while to examine under the collecting lens every promising patch of brown mud, for very pure gatherings of quite different species may often be collected within a few feet of each other. The species of which pure gatherings may be had in these pools are *Nitzschia epithemioides*, *Navicula veneta*, *Epithemia musculus*, and *Scoliopleuro tumida*.

A few rods south of the landing at the inlet is a flat which is uncovered at low water. Here may be collected *Schizonema Americanum*, *Schizonema Grevillii*, and *Berkleya fragilis;* and lodged upon the shells, and growing upon the piling, specimens of algæ may be obtained, which are often loaded with *Cocconeis* and other diatoms.

Out in the bay may be found flats, often acres in extent, where eel-grass is abundant. The grass is often loaded down with alga, which is parasitic upon it, and the alga in turn is often full of diatoms. As the water is shallow, a crab-net answers very well for dredging purposes, a single haul often furnishing a large lot of interesting specimens. I do not know what a visit to these flats in winter would reveal, but in August they are rich collecting-grounds

It is also worth while to visit Longport, south of Atlantic City, for here, when the wind is west, quantities of algæ are blown over and stranded upon the shore of the thoroughfare. It may be mentioned in passing that the red species of algæ are the most prolific.

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*Reprinted from *Torrey Bulletin*, May, '88.

The pools that are so frequent upon the vast meadows that lie between Atlantic City and the mainland are also excellent collecting places. On sunny days the surface of these pools is often almost covered with diatoms. *Scoliopleura tumida* and *Pleurosigma Balticum* may often be obtained here in great quantity. Other species of *Pleurosigma* and *Amphiprora pulchra* are not uncommon. In visiting these pools it is best to leave the train at Absecon station and visit those nearest the mainland, as those near Atlantic City are much contaminated with sewage.

In the brackish ditches the curious and ever interesting *Bacillaria paradoxa* may often be obtained in abundance, sometimes clinging to the stems of water plants, but oftener in little patches upon the surface of the water.

Appended is a list of the species observed mostly during the spring and autumn months:

IN THE MEADOW-POOLS NEAR THE INLET.

Amphora costata, Gregory, *A. lanceolata*, Cleve, *A. lineata*, Greg., *A. plicata*, Greg., *A. rectangularis*, Greg.; *Biddulphia rhombus*, W. Smith; *Coscinodiscus omphalanthus*, Ehrenberg, *C. eccentricus*, Ehr., *C. lineatus*, Ehr.; *Epithemia musculus*, Kutzing; *Navicula amphisbœna*, Bory, *N. peregrina*, Ehr., *N. permagna*, Bailey, *N. prætexta*, Ehr., *N. veneta*, Kutz.; *Nitzschia bilobata*, W. Sm., *N. Epithemioides*, Brebisson, *N. marina*, Grunow, *N. Sigma*, W. Sm., *N. vivax*, W. Sm.; *Pleurosigma Balticum*, W. Sm.; *P. fasciola*, W. Sm.; *Rhaphoneis amphiceros*, Ehr.; *Scoliopleura tumida*, Rabenhorst; *Stauroneis aspera*, Ehr.; *Triceratium alternans*, Bailey, *T. favus*, Ehr.

ON ALGÆ IN THE BAY.

Achnanthes brevipes, Agardh; *Berkleya fragilis*, Greville; *Biddulphia aurita*, Breb., *B. lævis*, Ehr., *B. pulchella*, Gray; *Cocconeis scutellum*, Ehr.; *Grammatophora marina*, Kutz.; *Licmophora flabellata*, Ag., *L. tincta*, Grun.; *Melosira nummuloides*, Kutz.; *Rhabdonema Adriaticum*, Kutz., *R. arcuatum*, Kutz.; *Schizonema Americanum*, Grun., *S. Grevillii*, Ag.; *Striatella unipunctata*, Ag.; *Synedra fulgens*, W. Sm.

IN POOLS ON THE MARSHES NEAR THE MAINLAND.

Amphiprora pulchra, Bailey; *Bacillaria paradoxa*, Gmelin; *Melosira nummuloides*, Kutz.; *Pleurosigma Balticum*, W. Sm., *P. fasciola*, W. Sm., *P. hippocampus*, W. Sm.

IN BRACKISH DITCHES AND MARSHES NEAR ABSECON.

Actinoptychus undulatus, Ehr.; *Amphiprora pulchra*, W. Sm.; *Cocconeis scutellum*, Ehr.; *Coscinodiscus subtilis*, Ehr.; *Cyclotella operculata*, Kutz.; *Navicula elegans*, W. Sm., *N. didyma*, Kutz., *N. peregrina*, Ehr., *N. pusilla*, W. Sm., *N. Smithii*, Breb., *N. forcipata*, Grev.; *Nitzschia dubia*, W. Sm., *N. fasciculata*, Grun., *N. granulata*, Grun., *N. Scalaris*, W. Sm., *N. Sigma* (W. Sm.) var. *rigidula*, Grun.; *Rhaphoneis amphiceros*, Ehr.; *Rhoicosphenia curvata*, Grun.; *Stauroneis salina*, W. Sm., *Surirella angusta*, Kutz.; *S. Febigerri*, Lewis, *S. gemma*, Ehr., *S. Molleriana*, Grun., *S. ovata*, Kutz.; *Tryblionella levidensis*, W. Sm.

Micromillimeter.—A recent article in *Nature* speaks of the value of the micromillimeter which obtains among microscopical writers as a thousand times larger than the value of the same unit given it in the writings of physicists and accepted as authorities by a commission of the British Association. A micromillimeter has thus two meanings:—a thousandth of a millimeter and a millionth of a millimeter. It is suggested by Mr. A. W. Rücker that the botanists adopt the term *micrometre*, to stand for the thousandth of a millimeter. He recognizes its similarity to *micrometer* as the name of an instrument, but does not consider this a valid objection to its adoption.

Notes from a Foreign Land.

By ROMYN HITCHCOCK.

A large number of subscribers who have requested microscopic specimens from Japan have not yet received them. The reason is that I have not yet been able to collect a sufficient quantity of really good material to supply the demand. Probably none will be sent before next summer, when I hope to find an abundance of fine diatomaceous material in the course of my travels in the north of Japan.

There is a decided effort likely to be made to secure the admission of microscopes and other apparatus free of duty. I do not know just what position the Editor will assume in this matter, but it is very certain that there is much to be said on both sides of the question, and that the editorial views of every special journal will carry much weight. I can readily conceive that both sides would do well to urge their claims, for I really believe the movement on foot may result in a great reduction, if not the abolition, of custom duties on microscopes.

Photography offers but few novelties of interest to microscopists. Mr. Walmsley has lately made a demonstration of the value of ortho-chromatic plates in photo-micrography in Philadelphia, as I learn from the photographic journals. It is quite likely that such plates will prove of great advantage in photographing many specimens, particularly such as have much red or yellow in them. But those who for any reason cannot get the plates will find that a yellow glass interposed in the path of the light will greatly improve the results with such objects. The glass may be placed in any position, but probably the most convenient will be beneath the stage, or below the condenser. The action of the colored glass is to absorb the strongly actinic light, the blue and violet, thus lengthening the time of exposure and allowing the yellow rays a longer time to act upon the plate. The yellow light thus becomes more active relatively to the blue, and details in yellow parts of the specimen are brought out which would be invisible in a photograph taken in the usual manner.

A good substitute for yellow glass can easily be made by getting some plain collodion from a photographer and coloring it with yellow aniline. The depth of color can be varied, and it is well to have several shades to suit different objects. Aurantia is a good coloring matter for this purpose, recommended by Dr. Vogel. Use about five grains to two ounces of collodion. The yellow collodion is flowed over glass plates, an operation that may well be entrusted to a photographer, and afterwards varnished to protect the film. An alcoholic extract of turmeric may also be used in the same manner, and turmeric can always be found in drug stores.

Exposures with such color screens must be much prolonged, even as much as from five to ten times what would otherwise be required.

There have been various new devices for cameras to be used with the microscope figured in various journals, but the one that most highly commends itself, from the description in the *Journ. Royal Micr. Soc.* of December, is that of Mr. E. M. Nelson and Mr. C. L. Curties. It is made of two long, square card-board tubes, one sliding into the other. The microscope with its tube horizontal is placed in position on the base board, the object focused by the eye, the front card-board tube then pushed into position, and the projecting eye-piece used for the final focusing on the glass. It seems an excellent plan to be able to push the front of the camera back from the microscope far enough to get the head down to the microscope.

There may be something useful in the recent observations of Mr. Francis, of Sydney, Mr. G. D. Hirst, and Mr. E. M. Nelson concerning the increased

visibility of fine lines when examined with oblique light and a polarizing prism, rotated until it partly darkens the field, used above the eye-piece. It is said that the lines of *A. pellucida* become much more sharply defined with the prism, and even with lenses that give but indifferent resolutions without the prism they become quite sharp when it is used. The explanation given of this surprising result scarcely seems to explain, for it is merely this:—'Probably the efficacy of the prism, when used with a lined test, lies in the fact that it intensifies the diffraction spectra when it is placed in a certain direction to it,' which seems to signify that it increases the clearness of the lines because it does so.

Prof. Rogers' suggestion for a constant of nature seems exceedingly well-founded. It may at first seem surprising that the expansion of a bar of metal can furnish us with one of the most absolute constants we possess, but it seems to be a fact; and certainly it is the constant one most readily to be appealed to under all circumstances, and most conveniently measured with precision.

The limit of visibility of minute objects seems still to be misunderstood. The matter has been occasionally discussed in these columns, and it is unfortunate for Prof. Roscoe that he had not been a 'constant reader' of this JOURNAL before he ventured to deliver his presidential address before the British Association last year. He placed the limit of visibility at $\frac{1}{4000}$ of a centimeter, about $\frac{1}{10000}$ of an inch. Probably Dr. Royston-Piggott is the only person who claims to have seen $\frac{1}{100000}$ of an inch, but his claim seems to be well founded. In any case very much smaller specs than $\frac{1}{10000}$ have certainly been seen, and it would be interesting to know the exact size of the almost invisible spores that Dr. Dallinger has discovered, growing from an irresolvable cloud into visible germs, with all the organization and potency of life.

It is a pleasure to congratulate Mr. Wolle upon the completion of his valuable book on the fresh-water algæ. Although I have not seen the finished volume, its pages and illustrations will not seem unfamiliar to me, for many of the latter were already drawn before I left home, and much of the manuscript had been written. It is the result of long, meritorious, and enthusiastic work by an earnest student, whose years number already threescore and ten. I trust both the book and the author will receive the full recognition due them from students of the algæ in every part of the world. The two companion volumes, on Desmids and Algæ, are enduring monuments to the author's conscientious industry and accuracy of observation.

OSAKA, JAPAN, *March 9, 1888.*

The Microscope in Medicine.

BY W. D. BIDWELL, M. D.

In the practice of medicine and surgery everything is changed since the last century, and to no one factor is this change more due than to the microscope. A few of the benefits are these:—Anatomies of the present day give the histological structure of every part of the human organism, which adds as much to our knowledge of how the body is constructed as did dissection to those crude and even absurd ideas held by the early practitioners. Microscopical anatomy naturally led to a more exact physiology—the discovery of nerve fibres terminating in little plates in the skin of the finger necessarily gave a clearer idea as to how the sensation of feeling was received and transmitted. Every organ was better understood and its function made more evident by the use of the microscope.

In pathology the various diseased structures, tumors, and fluids are daily prepared and placed upon our slides. It is largely owing to the microscope

that autopsies prove interesting by showing what deviation from normal growth has taken place within the body, and it is by associating these conditions with the symptoms recorded in the history of the case that we are enabled to relieve the sufferings of others similarly afflicted. The microscopist determines the appropriate operative procedure in many a case of tumor. To the microscope we appeal to decide whether or not a patient's kidneys are all right, or whether the applicant for insurance is barred out by Bright's disease.

Bacteria, microbes, spores, have abounded for ages, but they accomplished their life work without hindrance, and the thoughtful doctor of years gone by, bewildered by changes the cause of which he could not see, summoned 'spirits from the vasty deep' and ascribed to them as miracles that which we, by means of our microscopes and culture gelatines, see to be merely the performance of a colony of cocci or bacilli. The whole germ theory, with its far-reaching, and, at present, but half comprehended bearings, is a child of the microscope.

In the detection of certain poisons, in the examination of drugs, in the analysis of drinking water, yes, in every branch and department of medicine, the microscope is the faithful ally, the ubiquitous servant of the disciples of Æsculapius.

Leavenworth, Kansas, *March*, 1888.

Practical study of blood.*

The blood of the newt is exceedingly favorable for microscopic examination, by reason of the relatively large size of the red corpuscles, which are about $\frac{1}{800}$th of an inch in diameter, or four times greater than the red corpuscles of human blood; and also on account of the normal temperature of the blood of the newt being but little beyond that of the atmosphere (hence the term cold blooded). The corpuscles thus retain their vitality for a considerable length of time, so that, if precautions be taken to prevent evaporation of the blood-plasma, any changes in form which the corpuscles undergo can be observed without the aid of hot stages or other artificial means for preventing the temperature of the blood falling. In vertebrate animals, in addition to the blood vascular system, there is another system of vessels containing a clear colorless liquid with numerous corpuscles, the lymph; and as in the newt and all amphibians the lymph vessels are relatively large and abundant, in order to obviate the admixture of the lymph with the blood and the consequent confusion of lymph corpuscles with white corpuscles, the blood for examination should be taken direct from the heart. The blood having been so obtained, and evaporation having been prevented by the application of melted paraffine to the edges of the cover-slip, the members were able to observe the amœboid movements of the white corpuscles, which are essentially similar to those previously noted in the blood corpuscles of the mussel.

The white corpuscles, which were somewhat smaller than the red corpuscles, varied in appearance as well as in size. They were all nucleated and granular, but some were more finely granulated than others, and the pseudopodia in the coarsely granulated corpuscles were more blunt and rounded than in the finely granulated one. The red corpuscles were all uniform in size and oval in outline, but when viewed upon edge presented a somewhat spindle-like or fusiform appearance. Each was of a faint yellow color, owing to the presence of hæmaglobin, a substance peculiar to blood corpuscles, and forming the greater portion of them, the remaining proteid matter being

* From report in the *English Mechanic* of a Meeting of the Manchester Microscopical Society.

known as the stroma. A lighter-colored nucleus was distinctly visible in each, which, though faint at first, became gradually more distinct. Another drop of blood being treated with magenta stain exhibited the presence of the nuclei in the corpuscles much more distinctly. In a red corpuscle the perinuclear portion was scarcely affected, whilst the nucleus was stained a deep red and revealed a still darker portion within the nucleolus, and each red corpuscle was evidently limited by a thin firmer membrane or envelope. The white corpuscles were stained more uniformly, but the nucleus was much more distinct than before staining, and in some cases was seen to be two or three partite. When treated with dilute solutions of hydrochloric acid and acetic acid, the red corpuscles became much more transparent and colorless, the nuclei darker and more definite, presenting a beaded outline, and, with careful observation, a distinctly fibrillar structure was visible, the appearance being somewhat similar to that previously observed in the nuclei of young vegetable cells.

In the case of the specimen treated with hydrochloric acid, rupture of the limiting envelope took place in many of the corpuscles, the hæmaglobin escaping into the surrounding liquid, showing the residual stroma in the form of bands extending from the nucleus to the limiting membrane.

When a sack or bag made of an animal or vegetable membrane, and containing a liquid, is immersed in another liquid of different density, it is well-known that the liquids tend to diffuse into each other through the membrane, and as usually the liquid of less density passes more rapidly through the membrane than the one of greater density, the bag may become swollen or may shrink according to the nature of the liquid it contains. A red blood corpuscle represents such a microscopic sack, so that when a drop of water was added to the blood under examination, the water passing into the corpuscles more rapidly than the hæmaglobin passed out caused them to swell, and thus lose their oval outline and become globular, this passage inwards of a liquid to an animal cell being known as endosmosis. Upon adding a strong solution of sugar to another drop of blood the reverse action took place. The hæmaglobin was now seen to pass out into the liquid more rapidly than the syrup passed in, causing the corpuscles to shrink or collapse and present the appearance of a misshapen sack. The process is known as exosmosis. These latter experiments are of value in demonstrating the laws of osmosis, by which the various liquids diffuse themselves through the tissues, both of animals and of plants, and are also interesting to the practical microscopist by showing why it is that for microscopic examination animal and vegetable tissues should be mounted in fluids as nearly as possible of the same density as the liquids that surrounded them in their living state, if the cells are to preserve their true form and appearance.

In the next demonstration of the systematic course it is proposed to proceed with the examination of the blood of birds and of mammals, including human blood; after which the microscopic examination of the chemistry and physics of the vegetable cell will be undertaken.

REPORTS OF RECENT ARTICLES.

The waters of New York harbor.—Dr. J. J. Kinyoun, Assistant Surgeon United States Marine Hospital Service, has recently made a careful examination of the waters of New York harbor, showing conclusively that the germs of cholera and many other infectious diseases are capable of living and multiplying indefinitely therein.

The cities discharging sewage into New York bay have a population of 3,000,000 people. Specimens were obtained at the incoming tide from the Narrows, from the side of the steamship *Britannia* lying in quarantine, from near Hoffman's island and Swinburne island. A chemical examination demonstrated that the amount of organic impurity was very great, and about the same in each of these samples. The samples were collected in sterilized flasks; and in order to ascertain the nature of the bacteria contained therein, and determine how long they would support life of the different micro-organisms, the following experiments were made:—

'Plate cultivations were made from each of the different specimens, and, at the end of five days, had developed colonies of bacteria. Examination showing the number of micro-organisms:—Narrows, 4,500 to cubic centimeter; *Britannia* anchorage, 10,200 to cubic centimeter; Hoffman island, 9,600 to cubic centimeter; Swinburne island, 11,700 to cubic centimeter.

'The micro-organisms found in each were several varieties of micrococci and one of a large bacillus. These were transferred to cultivation tubes for further observation. On November 12, test-tubes, partly filled with sea-water, were thoroughly sterilized and inoculated in the usual manner with pure cultivations of the spirilla of Asiatic cholera, and also of Finkler and Prior. Cultivation-tubes were inoculated from the water from day to day, for the purpose of determining the longevity of the growths. During the first five days, the water seemed to exert a slight inhibitory influence over their development. It was further observed that until January 20, a period of sixty-nine days, the characteristic growth of the spirillum of cholera Asiatica could be produced in peptone gelatine. That of Finkler and Prior has a yet longer lease of life.

'Examinations made from time to time, both by the plate method and direct staining, show conclusively that these spirilla have not only been kept alive, but have also greatly increased in numbers.

'After closely studying the currents of the upper bay, I am led to believe that if dejecta from cholera patients should be thrown into the lower bay, cholera could gain a foothold on the contiguous shores, where every condition favorable to its development and propagation sometimes exists.'—*Buffalo Medical and Surg. Journal.*

Notices of New Methods.—IV.

By GEORGE C. FREEBORN, M. D.,

INSTRUCTOR IN NORMAL HISTOLOGY, COLLEGE OF PHYSICIANS AND SURGEONS, NEW YORK CITY.

Safranin Solution with Aniline Oil.* V. Babes.—To 100 parts of distilled water, an excess of powdered safranin and 2% of aniline oil are added. The mixture is heated to 50° or 60° C., and filtered warm through a moistened filter. This gives a deep red fluid which stains in from one to two minutes. After staining, the sections are passed through alcohol, cleared in oil of cloves, and mounted in Canada balsam. This solution stains calcareous matter red-violet, and is especially useful for staining bacteria and karyokinetic figures.

The author has also combined this stain with Gram's method for isolating Actinomyces elements, staining calcareous and hyaline degeneration and certain abnormal karyokinetic figures.

The sections are stained for twenty-four hours, in the above staining fluid, then treated for one minute with Gram's fluid, then washed in alcohol, cleared in oil of cloves, and mounted in Canada balsam.

* Arch. f. Path. Anat. u. Phys. cv. 1886, p. 590-596, also Z. f. W. Mikros. iv, 1887, p. 470.

The author also recommends this latter method for staining sections of the central nervous system, that have been hardened in solutions of chrome salts, whereby the same elements are stained as with Weigert's hæmatoxylin or acid fuchsin.

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Methods of Examining Motor Nerve Endings.* W. Kühne.—The author recommends the following methods as giving the best results:—

1. Lowit's gold method, with the subsequent treatment of the tissues with the strongest formic acid. Especially useful for unfibrillated muscle.

2. Soaking the tissues in $\frac{1}{2}\%$ solution of formic acid, then in 1% solution of auric chloride, reduction, in the dark, in a mixture of glycerine and water, equal parts, with the addition of $\frac{1}{4}$ to $\frac{1}{2}$ its volume of formic acid. Useful for muscles of warm-blooded animals.

3. The same as 2, without the previous soaking in formic acid. Useful for cold-blooded animals.

4. Golgi's method. Soak in a $\frac{1}{2}\%$ solution of arsenic acid, then in auric and potassium chloride, reducing in a 1% solution of arsenic acid in the sunlight. Useful for all objects.

5. An alteration of 4. The muscle strips are placed in a mixture of $\frac{1}{2}\%$ arsenic acid, $\frac{1}{4}\%$ of auric and potassium chloride, 0.1% of osmic acid. Then in 1% solution of arsenic acid. Reduce in the sunlight. Best for the reptilien tissues.

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A Modification of the Usual Methods of Studying Nerve Endings with Auric Chloride and its Employment on the Muscles of the Frog.† G. Boccardi.—The muscles are first treated with lemon juice after the manner of Ranvier, then with auric chloride, or a mixture of auric chloride and formic acid, then washed in water and placed in a $\frac{1}{4}$ to 1% solution of oxalic acid for two hours, or, what is better, in the following mixture: Formic acid 5 c.c., 1% solution of oxalic acid 1 c.c., water 25 c.c., then wash in water and mount in glycerine.

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A New Method for Microscopical Examination of Blood.‡ D. Biondet.—Not more than two drops of blood are allowed to fall into 5 c.c. of a 2 per cent. solution of osmic acid, contained in a small glass cylinder. The solution of osmic acid is to be filtered before use, to remove all granules, etc. The acid is allowed to act for twenty-four hours in the dark. At the end of this time, four or five drops of the mixture of blood and osmic acid are removed with a pipette and added to a test tube of agar agar, which melts at a temperature of 35° to 37° C., the tube is well shaken, and the contents poured into a small paper box. When the agar agar has become solid, the paper is removed and the agar block placed in 85 per cent. alcohol to harden. The agar agar imbedding may be combined with paraffin as follows:—The agar block is removed from the alcohol and placed in oil of bergamot for twenty-four hours, then direct in paraffin, melted at a temperature of 45° C. for one to two hours; finally imbed in a paper box.

Thin sections are made, with a microtome, from these blocks, stained in the usual manner and mounted in balsam. The paraffin is removed from the sections, before staining, with any of the usual solvents.

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* Zeitsch. f. Biol. xxiii, N. F., V., 1887, p. 1.
† Lavori eseguiti nell' Ist. fisiol. di Napoli Fasc. 1, 1886, p. 27.
‡ Arch. f. Mikros., Anat. xxxi, p. 103, 1887.

EDITORIAL.

Photomicrographs.—We have received a set of several photomicrographs from Mr. Geo. W. Rafter, from whose letter we quote as follows:—'The pleurosigmas may serve to illustrate my paper on "Use of Amplifier." The pleurosigmas of 400 diameters are with $\frac{1}{5}''$ objective of B. & L., student series, and illustrate in the strongest manner the value of the amplifier. The other pleurosigmas are with B. & L. $\frac{1}{8}''$ first-class, and I think I may say they compare with any yet made. The plant sections are with B. & L. 2″ professional, without amplifier.' The photographs are very fine, indeed. The *P. angulatum*, with power of only 400 diameters, if examined with hand lens, even bears comparison with the picture of *P. angulatum* magnified 900 diameters with amplifier. The latter is as good as any which we have ever seen. The 'beading' is shown as clearly as it could be seen with a microscope. The plant sections are admirable. In one of them—the cross-sections of the stem of sumach—the gross structure is shown as clearly as it could be shown by the most faithful and careful draughtsman. It looks almost as if photographed from some of the wonderful figures in Sach's text-book. We shall be glad to send these photographs to any who care to examine them and will return them free of cost to us.

He has also sent a second large series of 22 prints from plant sections and 18 diatoms which show admirable work. In most of the prints the features of the original are reproduced with almost as perfect clearness as in the original view. The *P. angulatum* magnified 900 diameters is a marvel of clear, crisp definition, thoroughly well illuminated, as is also *Cymbella gastroides* magnified 1000 diameters. The plant sections from Phænogam stems are all of them excellent, and could be passed about at a society to illustrate any point in the structure which it might be desired to demonstrate.

And this brings us to a second thought in connection with the gift of Mr. Rafter, which is the place which photomicrography plays in the studies of a biologist. It has always been our opinion that a *perfect* representation on paper from a prepared slide could not be made by photography. We emphasize the word perfect, for we think that next to the drawing by an actual artist who can put together the result of several looks at various focal levres the picture of the camera is perfection. Every one who understands what a boon the camera lucida is can see the value of the photographic camera. The greatest benefit, however, from the photomicrograph is the result—a picture which can be passed around at the club meeting or in the lecture room to illustrate a slide. It does away with the cumbrous and inconvenient magic-lantern, and enables one to illustrate most conveniently. For lecture room or club meeting the photographs are most useful. Mr. Rafter has also offered an important suggestion that in staining sections attention be had to the value of the mount for photographic purposes.

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Physiological reversion and the Darwinian theory.—Dr. T. W. Mills, of McGill College, Montreal, has, in a recent article,* attempted to show the meaning of certain facts, some of which were of his personal observation and others which are well known. His paper, as he says, is not the first, Dr. Fothergill, of London, having, in 1886, unbeknown to the author, enunciated the same principle. After speaking of the well-known embryological fact that the highest mammals pass through stages of development closely allied to permanent forms of groups of animals lower in the scale, the author proceeds to show that the organs of the higher animals strongest in coping with disease are those which have been acquired, and which are not pos-

* Science, vol. xi, p. 79.

sessed by the lower animals; or, to put this in another way, that the very organs which are highest are the most open to disease attacks and yield most easily. We cannot repeat the evidence adduced to prove this most interesting statement of the result of his observation, but we notice at once the cause which is assigned for the fact. He seeks to explain it by reference to a principle which he calls physiological reversion, and to account for the greater vitality of parts common to higher and lower animals by reference to the supposition that these have been used longest in the development of the race and hence are strongest. Thus he brings the facts into harmony with Darwin's principle of evolution. He goes further and shows that these facts are not readily explained upon any other supposition. Thus, for a single instance, in death of the heart of the turtle, as of all cold-blooded animals, as well as the mammals, the various parts always die in a certain order, and the ones last to appear are the ones which are first to die. Upon the Darwinian hypothesis it is intelligible why the youngest part of the organism—the one latest to appear in the line of descent—should be weakest and least vital, and it is not in the least so upon any other.

We have space here only to point to this article and to the line of observation and study which it suggests, for the twofold purpose of showing, firstly, to the physicians among our readers one way in which they may utilize the results of their very numerous opportunities for observation, namely, by contributing what will prove or will disprove the principle set forth; and, secondly, of showing, with regard to Darwin's theory, how very far-reaching it is, and how it fits with facts drawn from the greatest variety of sources and harmonizes them all.

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A good manual of histology.—We have received from time to time inquiries for a good illustrated book, treating the topic of mammalian Normal Histology, and one which shall not be too expensive. When this question came up three months ago in an inquiry from a correspondent, we were forced to say that the book for a beginner to use alone, which contained good figures and did not cost too much, was not in existence. In spite of the numerous histologies it seemed to us that the requirement was not met. We were therefore heartily pleased to find in the work recently published by Dr. M. N. Miller, of the Loomis Laboratory in New York, a book which seemed precisely the thing to put into the hands of elementary histologists in classes, or to recommend to anyone desiring to initiate himself into the very difficult art of unraveling the structure of an organ from sections of that organ. The author's admirable plan is first to state clearly the structure of the organ and then to give students the detailed study of a section. For a beginner, the chasm from a section to the intelligent comprehension of the place of that section in the organ of which it forms a part, and the step thence to an understanding of the actual structure, is enormous and one which he only learns to bridge by slow degrees. We have had this fact demonstrated a hundred times, and have found very bright students who only gradually comprehended what they were about when they were studying a section. Dr. Miller's plan of giving *vis-a-vis* a study of the organ of the section receives our hearty sanction, with perhaps the very slight reservation that we prefer for the educational value of the study to have the section study come first. One who has drawn much can readily appreciate the patience and labor spent upon the illustrations which add so very much to the usefulness of the volume.

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Correction.—On page 29 of the present volume, February number, 'grns,' in the sixth, seventh, and tenth lines, should read grms.

NOTES.

Postal Microscopical Club.—The 13th annual report of this organization has just been received, and shows a prosperous condition of affairs. The society suffered considerable inconvenience from the postal regulation regarding advertisements printed with addresses, under which law the addresses of the boxes were supposed to fall. In spite of this and other difficulties, however, the Club has prospered and done its usual amount of good work, by circulating many most excellent slides and descriptions. Extracts from the note-books furnish many useful hints for practical use.

Palmer Slide Co.—We have received, recently, from this now well-known optical company, some samples of their slides and some of the mounts by Dr. Reeves, and the crystals by Mr. Bolton. Dr. Reeves is recognized as one of the best preparators in America, and his work is excellent. The Company advertises to furnish all manner of microscopical goods at very reasonable prices. Its present address is Cleveland, Ohio, instead of Geneva, N. Y., as formerly.

Davenport Academy of Natural Sciences.—The annual meeting was held January 4, 1888. The Secretary's report showed that seventeen meetings had been held, with an average attendance of fifteen. Seven regular and five corresponding members had been elected, making a total gain of twelve during the year. Three life members, one regular member, and one corresponding member had died, making a total loss of five. Present membership:—Life members, 77; regular members, 120.

Papers of scientific value read before the Academy:—Bibliography of Iowa Antiquities, Report on Thunder-Storms of Iowa, Fishes of the Ozark Mountains, Annotated List of the Birds of Iowa, Anglo-Saxon and Latin Words.

Subjects of more or less general interest discussed:—Clouds, How Sustained in the Atmosphere; Theories of Thunder and Lightning, The Stone Circles on Dakota Plains, English Sparrows, Theory of Color, Changes in Animal Life Caused by Salt or Fresh Water, Edison's Pyro-Magnetic Generator.

Lectures:—'The Vertebral System in Man and Animals,' and a costume lecture under the auspices of the Academy, 'The Indians of Iowa.'

The Librarian reported additions to the number of 2,025, among them transactions of 250 societies, the National and State publications.

In the museum the accessions comprise about three hundred vessels of ancient mound pottery, two hundred flint and stone implements, eleven human crania from mounds, one carved stone Indian pipe, two hundred and thirty-five old-time relics from New England, an old electrical machine, twenty-five species of fossils, several hundred species of recent shells. The collection of recent shells, which has been very largely increased by the labors of Mr. Harry A. Pilsbry, includes about twenty-five hundred species. A considerable number of the local species of fishes and reptiles has been collected and preserved.

MICROSCOPICAL SOCIETIES.

ESSEX COUNTY, N. J.—F. VANDERPOEL, *Secy.*

December 1, 1887.—Dr. R. R. Andrews, of Cambridge, Mass., spoke upon tooth development, and exhibited by lantern forty photomicrographs illustrative of his subject. Many of these he had made with an immersion $\frac{1}{12}$ and a $\frac{1}{75}$ objective. He considered all the stages of tooth development, but especially the formation of the dentine. His conclusions differ from the views of other investigators, and may be briefly stated as follows:—In the formation of dentine there are two varieties of cells called into action. The *odontoblast*, a cell which is flat and abrupt against the forming dentine, and the *fibril-forming* cell, which is pear-shaped, the odontoblast forming the basis substance of the dentine only, and the pear-shaped fibril cell forming the fibril of tomes. The fibril cell has a higher vital function than the odontoblast; that is, it supplies the nourishment to the basis substance. He described his method of preparing the specimens, which varies considerably from those of most investigators, as follows:—'I take the forming teeth from the jaws of embryos at, or nearly, the time of birth, while the tissue is still warm. These are placed in a quarter of one per cent. to one-half of one per cent. solution of chromic acid, which is changed daily for three or four days. At the end of this time the edges of the dentine that were calcified are found to be sufficiently

softened to make a number of sections. The teeth are taken from the acid solution, washed in distilled water, and then placed in a solution of gum-arabic for several hours. They are then put into a solution of alcohol to take out the water. Paraffine and lard are melted together and poured into a convenient mould. When the former is clouded in the process of cooling, the tissue, which has its outer surface dried as much as possible with bibulous paper, is placed in it and allowed to cool. Sections are now cut from it. The microtome which I use has an advantage over others, the tissue and knife both being under fluid when the sections are cut. The sections float off in the fluid and remain there until used. I cut until the calcified tissue is reached. The method has cost me a number of fine knives, for each cutting ruins an edge; but I have the satisfaction of working as near life as we can with our present knowledge. After cutting the sections they are placed in distilled water for a few minutes to dissolve out the gum, and are then mounted in Markoe's glycerin jelly. The difference in the appearance of the tissue prepared by this method is marked.'

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WASHINGTON, D. C.—E. A. BALLOCH, *Secy*.

Feb'y 28, 1888.—The 73d meeting. Prof. A. N. Skinner read a paper on standards of length, giving a full account of the measures of length in use at various times, and the origin of the same.

March 13, 1888.—The 74th meeting. Dr. Cooper Curtice gave a full account of the life history of *Taenia solium*, illustrating his paper largely by the use of specimens and diagrams. Specimens of *T. pectinata* and other tape-worms were also shown. Dr. Curtice will gladly identify specimens of tape-worm which may be sent him at the Department of Agriculture, for the sake of the specimens.

March 27, 1888.—The 75th meeting was held at the residence of Dr. E. P. Howland for the purpose of giving him opportunity to show his apparatus for projection. Both microscopic slides and lantern views were projected with great success, the light being furnished chiefly by the electric arc light.

April 10, 1888.—The 76th meeting. Dr. J. M. Lamb remarked on serial section-cutting. I have tried all the various mixtures recommended as imbedding-masses for serial section-cutting, and have at last settled down upon paraffine, pure and simple, as the most satisfactory. A proper consistency may be obtained by using paraffines of different degrees of hardness. I have also found that a proper consistency may be obtained by varying the temperature of the room, and in some cases where the paraffine was too hard I have succeeded by heating the point of the microtome knife gently by the flame of a spirit lamp, and cutting with the heel. Where all these fail, I imbed the mass anew and try again.

Dr. Blackburn testified to the efficiency of paraffine as an imbedding mass for this purpose.

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LEAVENWORTH MICROSCOPICAL SOCIETY.—W. D. BIDWELL, *Secy*.

March 19, 1888.—This monthly meeting, held at the 'Delmonico' parlors, was of the nature of a soiree, friends of the members being present by invitation. Dr. W. D. Bidwell read a paper on the value of the microscope in the medical profession. Prof. W. D. Lighton spoke of the construction and use of the immersion lens. Drs. O. C. McNary and C. R. Carpenter made remarks on crystallization. Nine microscopes and fifty slides were exhibited and explained to the visitors. The next meeting to be held at Prof. Lighton's residence; subject, 'blood.'

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LOUISVILLE MICROSCOPICAL CLUB.—SIMON FLEXNER, *Secy*.

Tuesday, March 30, 1888.—The Club voted to go into morning session, when a number of objectives, among them a $\frac{1}{12}$ in. first-class Bausch & Lomb, were tested. The $\frac{1}{12}$ in. was thoroughly tested on *Amphipleura*, including the difficult one from Floyd Co., Ind. It proved a very satisfactory lens.

Dr. Charles Mitchell, of Nashville, Tenn., was elected an honorary member of the Club. The doctor has just received a new $\frac{1}{10}$ in. 130° B. A. from Spencer. It is a beautiful working lens, and readily spoke for itself.

Contributions were received from Miss M. A. Booth, Longmeadow, Mass., nine slides of recent and fossil diatoms beautifully prepared, and from Dr. John Sloan, New Albany, Ind., 24 slides of named diatoms prepared in his usual excellent manner.

NOTICES OF BOOKS.

Epitome of Anatomy. By H. H. Culver. Boston. Ginn & Co. 1888. pp. 22.

This is a set of tabular synopses of the terms used in anatomy, physiology, and hygiene, an outline for helping the student to put into scientific form for ready review his knowledge on the subject. As such it is a successful presentation of the facts of chief importance. We should propose a different arrangement in some places. Thus the salivary glands are placed with other glands—the liver, pancreas, and stomach glands, etc. We should prefer to speak of them under the description of the mouth of which they are a part, physiologically and morphologically as well. The work is explicit upon the action of alcohol on all parts of the body, though in some of the points stated it would have been well to indicate that they are still in dispute. Upon the whole it is a useful book and can well be used by any student of physiology.—O.

Microscopic Botany; A Manual of the Microscope in Vegetable Histology. By Edward Strasburger. Translated by Rev. A. B. Hervey. Boston. S. E. Casino. 1887. pp. 382; 114 figures. Price, cloth, $2.50.

The student who desires to enter upon the investigation of vegetable histology need search no further than the most admirable work of Strasburger called, in the German parlance, *Botanische Practicum*, or, as we should say, Practical Botany. The original work was followed by an abridgement, *Das Kliene Botanische Practicum*, and the work before us now for review is an English translation of the 'Smaller Practical Botany.' It is complete in itself, but not so extensive as the larger work, which has also been translated into English. But it is as thorough and comprehensive as anyone, except a special investigator, would require. The purpose of the work is to train the user in the details of microscopical manipulation for the study of the vegetable tissues. Prof. Strasburger has won a world-wide name among biologists for his wonderful histological skill. The brilliant results attained in the domain of nuclear investigation prove him a thorough master of histological technique. In his work he brings together the results of his own studies and of other workers in this department. He presents the reader with innumerable 'schemes' for demonstrating the difficult facts of cell structure.

The book is divided into such lessons as these :—

Lesson II. Gluten; Fatty oils; Making permanent preparations; Use of the simple microscope.

Lesson V. Tissue; Thickening of the cell wall; Reaction on sugar; Inulin nitrates; Tannin; Wood substance of Lignin.

XV. Structure of the Foliage leaves and Floral leaves; The ends of the Vascular Bundles.

To illustrate how careful he is to set the worker on the right track let us quote from the study of the fibrovascular bundle of the fern rhizome :—'Make a section of *Pteris aquilina* in which it is possible to get a good knowledge of the vascular bundle. The numerous sclerenchyma (?) strings in the fundamental tissue do not permit us to make a good section. Make the section from the rhizome directly behind the growing point or through the petiole of a young leaf. The vascular bundle will be sufficiently developed, while the fundamental tissue will not be much hardened.' A brief caution of this sort, and such are to be found at every step, will save the student a world of vexation of spirit and much weariness of the flesh. It is so obvious that most writers would think it useless, and yet it is obvious only to the expert. Nothing is obvious to a beginner.

In style the work does not follow the method in vogue in manuals, so commonly in which each step is distinctly laid down, as, for example, in the most excellent Practical Biology of Huxley and Martin. We can but think that for the purposes of the laboratory some such style would be gain. The meaning is, however, entirely clear, and any thoughtful reader or student will not find any serious hindrance from it. We can not better characterize the style than in the words of Prof. Goodale, from a book notice in the *American Journal of Science*, in which he speaks of *Botanische Practicum* :—'One of the charms of the book consists in the almost colloquial minuteness with which all possible difficulties are explained to the student of histology. No hand-book dealing with manipulation should fail to give even fussy details, rather than leave the student to find out all such minor points of practise for himself.'

For the publishers we may say that the book is printed on good paper, strongly bound, and calculated for the heavy wear of a laboratory manual. It is in size uniform with

Brook's Zoölogy, but not in style. While some object to the size and weight of this for a manual of its sort, we cannot but think that durability is a consideration, and that for the amount of matter the size is not excessive.

The illustrations, of which there are an abundance, are excellent for their clearness, and, at the same time, for their avoidance of too great abstractness. While sufficiently diagrammatic for clearness, they do not lose the effect of reality, and they resemble good sections of which they are pictures. For the help of any who desire to hunt up for themselves the original articles upon the subjects of the various lessons, a list of references is appended to each lesson. The importance of this to the investigator cannot be overestimated.—O.

Elementary Microscopical Examination. By T. Charters White, late President of the Quekett Club. 104 pp. London. Roper & Drowley.

We take from a review in *Nature* a brief notice of the work, not having yet seen it. The author has aimed at leading 'the possessor of his first microscope into the smooth path of progress by pointing out the simplest and most elementary methods of observation, and, after so far clearing the way, leading him gradually to the higher branches of microscopical manipulation.' The book is pronounced by its reviewer to be one which, in spite of some inaccuracies, far excels in merit many and more pretentious works on the subject.—O.

Book Chat.—To one who wishes an index of current literature we should recommend *Book Chat*, by Brentano, 5 Union Square, N. Y., which has, during the first 3 months of 1888, indexed 524 new American and English works, reviewed 124 new books, indexed 3627 magazine articles contained in 799 periodicals, and noted 145 French, 115 German, 34 Spanish, and 52 Italian books.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

OFFERED.—Diatomaceous earth from Thibet, various localities (12,000 feet); also, material and slides of diatoms from Scottish Highlands, and continental foraminiferæ. WANTED.—Slides of American diatoms, insects, or botany.
W. D. STEWART, 2 Gilmore Terrace, Edinburgh, Scotland.

OFFERED.—Sections of vegetable ivory and slides of crystalized maple sugar. Good mounts taken in exchange.
WM. LIGHTON, 106 Fifth Avenue, Leavenworth, Kansas.

WANTED.—Parasites and books on Parasites and other micro. subjects. Will give Anatomical, Pathological, Botanical, Micro-fungi, Zoophytes, Polycistinæ, Foraminifera, Parasites, and other slides in return.
FRED. LEE CARTER, Gosforth, near Newcastle-on-Tyne, England.

Wanted, Diatomaceous earth from Mégillanes, Bolivia, South America. Can give in exchange either Diatomaceous earth from New Zealand or cash.
E. MICHALEK,
I. Fleischemarkt, No. 1, Vienna, Austria.

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W. C. BORDEN, M. D., U. S. A.,
Fort Douglas, Utah.

Wanted, earths, recent diatoms, and miscellaneous objects for mounting. Only first-class material offered or desired.
MARY A. BOOTH, Longmeadow, Mass.

Fossil Diatomaceous deposits (marine) wanted from Bermuda, Virginia, Maryland, California, etc.
I. ELLIOTT, Ardwyn Villa, Aberystwith, Wales, England.

Labels for slides.
EUGENE PINCKNEY, Dixon, Ill.

Correspondence relative to exchange in microscopical material or prepared mounts.
HENRY L. OSBORN, Hamline, Minn.

Notices.—All communications for publication should be addressed to Henry Leslie Osborn, Hamline University, Hamline, Minn.

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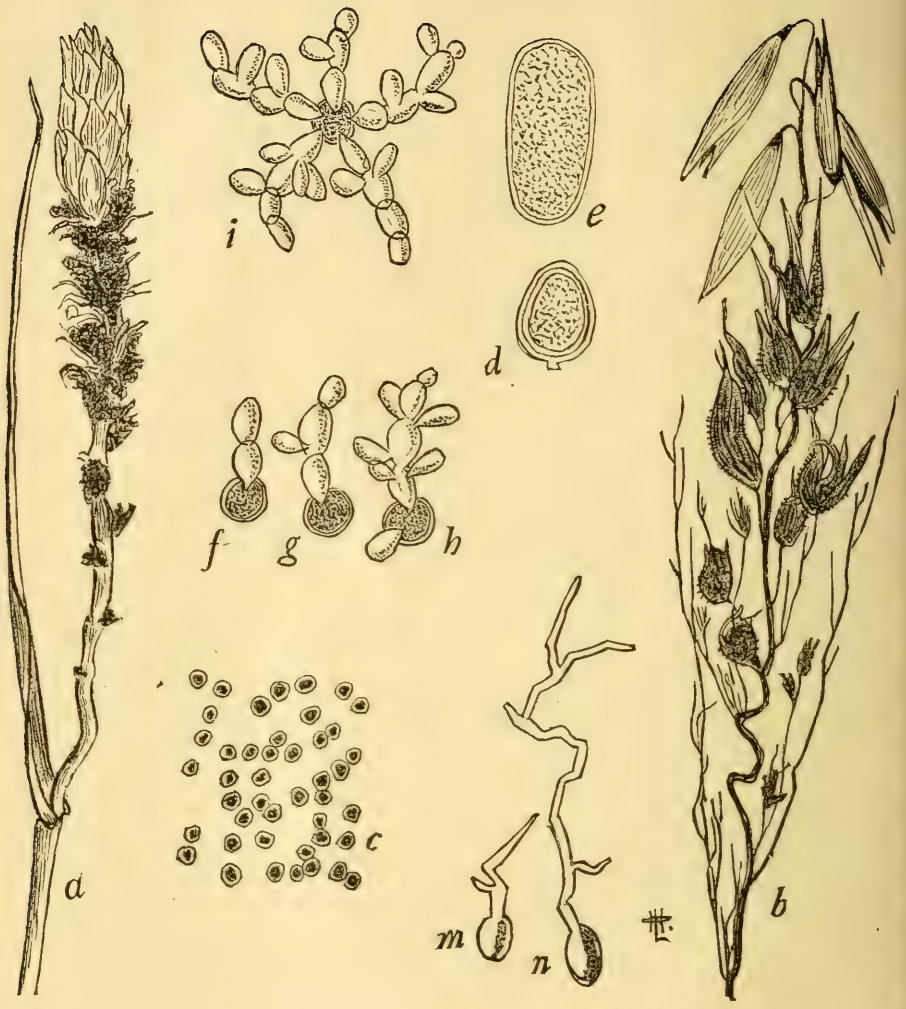

SMUT OF WHEAT AND OATS

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Smut of wheat, oats, and barley.*

Ustilago carbo. Tul.

Even the most unobservant person who has walked through a field of wheat, oats, or barley must have noticed smutted ears. Instead of the healthy spike or panicle of grain, sooty and ragged masses of black dust and scales are seen surmounting the fruiting stems of the corn. In some places the disease is called 'chimney-sweeper,' in others 'black-ball,' 'dust-brand,' or 'smut.' In certain districts it is erroneously termed 'bunt,' which is a totally different disease of corn. The black powder is produced in such profusion that it is impossible to gather a few diseased ears without the hands being soiled as if with soot. We have heard smutted ears called 'the male flowers of corn,' the erroneous idea being that these diseased ears are the black pollen-bearing plant. Some districts are more liable to smut than others, although none are free. At times the disease is extremely destructive, especially in oats. In some instances nearly the whole crop becomes smutted, and in bad cases from one-sixth to one-third of the crop is destroyed. When smutted wheat is ground with sound grain it not only discolors the flour but injures it as food. Straw infected with the black powder or spores of the fungus are disliked by cattle, and it is an offensive adjunct to chaff when given in food to the animals.

The smut disease of corn is caused by the presence of a fungus which exists within the tissues of the plant, grows with the growing stem, and at last bursts from the inside of the plant outwards at about the time when the corn is reaching maturity. The name of the fungus is *Ustilago carbo*. The name is derived from *Ustio*, a burning, and *carbo*, charcoal; having direct reference to the burnt and sooty appearance.

A close examination of the extremely curious fungus which causes smut shows how it invades the corn. If we take smutted ears of wheat and oats and examine them without a glass we shall see them as at *a* and *b*. The first point to be specially noted in the field is that every ear which springs from one root is smutted. This fact indicates that the disease springs from the base and runs up every stem from the ground line. A further proof is that the lowermost part of the ear is the part that first shows the disease. It is common to see the bottom of an ear of wheat or barley or of a panicle of oats badly smutted and the top sound. The disease in these instances has not

EXPLANATION OF THE PLATE.

a. The smut fungus, *Ustilago carbo*. Tul., in wheat.
b. The same in oats.
c. Spores of *Ustilago*, magnified 400 diameters.
d. Spore of potato fungus, magnified 400 diameters.
e. Spore of onion fungus, magnified 400 diameters.
f, *g*, *h*, *i*. Spore of *Ustilago*, germinating, magnified 1,000 diameters.
m, *n*. Growth of hyphæ in *Ustilago*, magnified 1,000 diameters.

* From Journal of Microscopy and Natural Science, April, 1888.

yet reached the top of the plant; one never sees the top of an ear diseased and the base sound. It is an undisputed fact that in smut the disease grows inside the stem from the bottom upwards.*

Now take a dwarfed and diseased cluster of grains and chaffy scales from a wheat-spike and magnify with a lens five diameters. The chaffy scales are rent and torn, and from every fissure the fine sooty powder is bursting out. If the cluster or spikelet is cut across it will be noticed that the whole farinaceous material of the interior has been replaced by one compact mass of fine black dust. The upper part of the stem of the corn, and the scales and grains alike, are infested and choked by the sooty powder. Take a fragment of one of the chaff scales and magnify it with a microscope 25 diameters, numerous cracks, some large, others small, will appear, and from every crack the fine jet black powder will be seen bursting out from the inside.

Every grain of this black powder is a minute spore or seed of the smut fungus. In an early stage of the disease, a state seldom noticed by farmers, the fungus is colorless; it grows within the stems of corn as fine transparent threads, immeasurably finer than any spider's thread. These threads at length reach the ears, the scales, and the infant grains. Here they form within the substance of the plant a whitish viscous mass of threads and cells, and this mass gives rise to an immensely large number of spores which quickly become black in color, burst through the tissues, and so reach the outside air. The fungus always grows so luxuriantly in the ears that nothing is ultimately left of the part which should bear the grain but a few dry vegetable threads, which are speedily torn apart, and this wreck of what should be the ear is soon carried away by the wind. As a rule, the ears, whether of wheat, oats, or barley, are totally destroyed by the fungus.

The particles of black powder are excessively minute in size. If they are magnified 400 diameters, they are seen as at *c*. An idea of their extreme smallness may be gained by comparing them with a seed or spore of the potato fungus, illustrated on the same scale at *d*, or with a seed or spore of the putrefactive mildew of onions, shown on the same scale at *e*. Two hundred spores of smut fungus could find ample room inside a single spore of the onion fungus (*c*), *Peronospora Schleideniana*. Owing to their extraordinary smallness, the spores of the smut fungus find their way everywhere; they are also produced in such profusion that in a smutted district there is not an inch of ground free from them.

The spores of the smut fungus, on germination, of course reproduce the disease in cereals. They do not germinate on dry ground, nor in dry air, but retain their vitality, if kept dry, for at least a year. Smutted ears have been kept in papers for a year in a dry room, and at the end of this time the spores of the fungus had suffered no injury. The spores, like ordinary seeds, require moisture for germination, and if they are put in a film of water they will germinate in from six to twelve hours. The very highest powers of the microscope are required to see this germination, and if objectives are used which magnify one thousand diameters, germinating smut-spores will be seen as at *f*, *g*, *h*. On germination, the outer coat of the spore bursts or cracks, and out of the fissure a minute transparent bladder emerges, which by budding soon gives rise to a second cell or bladder, as at *f*. As growth is continued, further budding takes place, at right and left, as well as at the top of the buds, as shown at *g* and *h*. If the spores are grown in the juices from farmyard manure diluted with water, the budding becomes much more profuse, as at *i*. This bursting and budding of the minute spores, which can be observed under the microscope, takes place naturally in the ground in

*Also easily proven by study of the hyphæ in the stem; the youngest ones being found in the youngest tissues.

damp weather, and the purplish black smut-spores give place to innumerable quantities of these excessively small, transparent, spore-like bladders.

It is a remarkable fact that these buds from smut-spores cannot be distinguished under the microscope from yeast. They are capable of growing and multiplying for an indefinite period of time in this yeast-like condition. Yeast being a fungus, observers are not wanting who say that germinated smut-spores are not only like yeast, but that they are yeast itself. Whether this is correct is uncertain, but the fact remains that yeast and germinated smut appear identical. Both excite alcoholic fermentation. Smut-spores which have germinated in the fields lead a non-parasitic life in and on the ground. It is remarkable that the yeast-like buds from smut-spores are not only capable of producing a vast number of other yeast-like buds, but some of these buds, probably influenced by external dry or other conditions, produce, on germination, extremely fine attenuated threads, as illustrated at *m* and *n*. These attenuated threads are also produced on and in the ground, and they secure access to cereals in the following manner :—

After the seeds of wheat, oats, and barley have been planted, the first green leaf from the seed speedily appears above the ground. In order to perform its vital functions, every leaf is furnished on its under surface with an immense number of minute orifices, which lead direct to the inner substance of the leaf. Through these little openings (stomata), the plant parts with moisture in the form of fine vapor. In damp weather every little opening or mouth stands wide open. At the same time, the yeast-like buds belonging to the smut-fungus are protruding their fine threads, as at *m* and *n*, upon the ground. These threads come in contact with the first young leaves of cereals, and enter among the tissues of the infant plants of wheat, oats, and barley by the minute open mouths or organs of transpiration belonging to the back of the leaves. When the fine smut-threads are once within the substance of the young cereals, they are in their natural position. They speedily find their way to the young stems, and, as the stems grow, the fungus grows too, and is carried up by the growing stems. When the ear or panicle is formed, all its parts, including the finest stalks, are invaded by the fungus, and in these parts of the plant it matures and produces its innumerable black seeds or spores which burst through the plant from its apex. From this position they once more reach the air and the ground.

In waste places the smut-fungus grows on a considerable number of wild grasses, such as darnel and the various wild oat, barley, and rye grasses. It can grow on no other plants except cereals and grasses.

Studies for Beginners.—III.

By H. L. OSBORN.

THE VINEGAR EEL.

A letter from a correspondent asking how to mount vinegar eels has suggested the topic for a third of these studies—the vinegar eel, *Anguillula acite*. The owner of a microscope, desirous of using it, can find material for study and observation everywhere. The old oaken bucket that hangs in the well, or the filth in the kitchen sink, a bit of the deal wood of the kitchen table, or the scraping from a surface of the skin will furnish, any one of them, abundant material for an hour of work, and would busy an expert for many months.

There is also an interesting object in the bottom of your vinegar cruet.

Go about the work thus :—First, be sure you have within easy reach the following utensils :—

1. Microscope with high ($\frac{1}{2}$) or low powers ($\frac{1}{6}$). 2. A number of clean slides and covers. 3. $\frac{1}{2}$ dozen watch-glasses. 4. A supply of bibulous paper. 5. Two dropping tubes and a couple of glass stirring rods. 6. A glass of water. 7. Some vinegar. 8. Reagents as follows:—1. Glycerine or glycerine jelly. 2. Alcohol. 3. Acetic acid. 4. Eosine.

The first step is the acquisition of skill in catching the material for study. To acquire this proceed as follows:—With one of the dropping tubes lift a drop from the sediment in the bottom of the supply. Catch this on the centre of one of the slides. Place the slide on the stage of the microscope and examine the uncovered drop with the low power, moving the slide about backward and forward with the sediment in sharp focus. If involved in the sediment is a long and narrow thread-shaped translucent body in quick motion, it is almost certainly the object of search. If one or more are not seen after the first lot has been searched through, try it over again until one of the wriggling bodies has been found. Having found one with the low power, hold the slide over a dark background. A piece of black cloth, or a black tile, is good for the purpose. Try to see the worm with the naked eye. One will soon succeed in doing this after having learned the sinuous motion which is habitual to the worm. Having acquired the necessary practice in detecting the specimen with the naked eye, collect an abundant supply for future use.

To do this, examine closely the vessel of vinegar. On the surface and on the side toward the window or source of light probably a great many of the eels are swimming actively about. With the pipette suck up a few of these and drop them into a watch-glass of pure water. When there have been removed to the pure water a dozen or so of the largest of the eels there is then sufficient supply of material for study. This process could not occupy the expert more than five minutes. It has a value in teaching carefulness and skill in delicate manipulation as well as in securing material for study.

Next, with the pipette, lift out of his watch-glass prison one of the eels and deposit it with the least possible fraction of a drop of water on a fresh dry slide. If the slide be moist the water will spread out over it in every direction, but if dry then it will remain in a small spot. Pour out a little alcohol into a watch-glass and add to it several drops of strong acetic acid. This is a killing fluid. Alcohol alone would be deadly, but of slower action. Place a drop of the killing fluid on the eel upon the slide. It would be useless to attempt to see it under the high power during its time of active movement, but it will soon become quiet enough for easy study. Do this with the high power first, covering the object with a cover-glass, and then running enough of the alcohol under the cover to entirely fill the space between it and the slide. The eel can now be examined at leisure.

Examination will convince one quite soon that the creature is not one of such simplicity as is implied by the popular expression, 'there is nothing to him,' but that he is very complex. First observe his shape—very long and narrow, blunt at one end, and sharply pointed at the other. Referring from him to a live one under a low power you can readily see that the creature always moves about pushing the blunt end forward, and this as well as other facts prove that his body has a head end, though it exhibits nothing which suggests a head separated by a neck from the body and bearing eyes or other sense organs. If now the high power study be resumed the various parts of this body can be distinguished, after very careful study, for the parts are transparent, and hence difficult to see. At the blunt front end of the body a notch marks the entrance to the digestive tube. The mouth can be seen leading into a straight thick-walled *gullet*, and this in turn into a globular *gizzard*. From the gizzard a tube runs straight through the body, which

terminates slightly behind the very acute tip in an opening (the anus). There is no distinction of stomach and intestine behind the gizzard.

When the parts of the alimentary system are thus made out, it is best to determine the exact situation of the skin or body wall, which may be best begun at the head end. It is partly of muscular tissue, overlaid with skin cells, and the whole covered on the outside with a chitinous cuticle, but these parts cannot be readily distinguished. When the body wall has been distinguished, search in the region of the stomach intestine for an organ besides it in this region. A difference will here be found among the specimens, some being males and others females. The organs here are the rather extensive ovaries or testes according to the sex of the individual. If a female, one will see numerous oblong or oval bodies separate from one another, many with a clear round central spot. These are eggs with their nuclei or germinal vesicles. Careful search of a number of specimens will further prove that an opening exists in the middle of the body. This may, perhaps, be traceable into the generative organ, into which it really leads. It is the reproductive orifice. The males have a different looking generative organ—the testes made up of numerous small round bodies, the ultimate cells which give rise to the spermatozoa, and which are 'peculiar in that they retain the character of cells, and may even exhibit amœboid movements' (Huxley).

Besides muscles, digestive organs, and generative organs the vinegar eel has a general nervous system which can only be demonstrated after very special study. It has no conspicuous sense organs. Its zoölogical relations are with the so-called round worms, many of which are man's greatest enemies, such as the Trichina; but Anguillula of vinegar is harmless. Other forms of Anguillula thrive in sour paste and still others are instrumental in producing a disease in wheat. Gordius, the 'horse-hair worm,' belongs to this group.*

It is scarcely possible to preserve the vinegar eel so as to show the facts pointed out as easily seen, and they can so readily be obtained at any time that it is scarcely worth while to attempt it. However, it may be done in one way, as follows:—As for staining the cuticle prevents the entrance of most stains, but eosine can be made to penetrate with difficulty.

In mounting the best method is as follows:—First get the specimen in alcohol in the centre of the slide. Then with the bibulous paper remove all alcohol from the slide, except just about the specimen; then, quickly, before the evaporation of the alcohol, drop on it a small amount of warm fluid glycerine jelly. Balsam should not be used (though it could be well enough), because of the similar density with the specimen, making the latter almost invisible. Cover the jelly with a cover and run in enough warm jelly to fill out the space between the slide and cover. After the jelly is hard wipe carefully away the excess at the point where the jelly was run under and ring with Bell's cement or with shellac cement. Slides made in this way will show the points above mentioned, or some of them, and will 'keep' indefinitely.

The student must be cautioned against expecting to find all the structure shown in any one specimen, because the position in which the body lies may hide some of them.

Minerals of New South Wales.—Prof. Liversidge, of the University of Sydney, has very aptly celebrated the centenary of the foundation of the colony of New South Wales by the publication of a treatise on the mineralogy of that country. A considerable space is devoted to gold, silver, gems, coal, lignite, mineral waters, rocks, etc.

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*Any who would care to know more of these animals will find help in the article Nematodea, *Encyclopædia Britannica*.

Practical study of blood.*—II.

(*Continued from page* 110.)

The examination of blood corpuscles was continued, the blood of the bird first claiming attention, the corpuscles being oval, nucleated discs, much smaller than those of the frog or newt. Upon the same slide a drop of frog's blood was placed for purposes of comparison, and as these corpuscles measure in their greater length about 1-1000th of an inch, they were found exceeding useful in determining the size of the other corpuscles. The presence of the nuclei was demonstrated both by treatment with acetic acid and magenta. The white corpuscles presented no features of special importance beyond those already observed in the blood of the newt.

The examination of human blood was next undertaken, no little amusement being caused amongst the members taking part in it when directions were given for each to prick his finger with a sharp needle for purposes of supply. This, however, can be done without any appreciable pain by tightly wrapping a piece of string round the end of the finger. Both the red and white corpuscles were examined, the red ones being circular bi-concave discs, a little less than one-third the diameter of the blood of the frog—that is, about 1-3200th of an inch—the thickness, when seen on edge, not being more than one quarter of this. A marked difference between this blood and the bloods previously examined was the tendency of the red corpuscles to run together into rouleaux like rolls of coin. Between these a few white corpuscles were visible, of irregular outline, and about 1-2500th of an inch in diameter. The absence of nuclei in the red corpuscles, and their presence in white corpuscles, was demonstrated by treating with magenta and with acetic acid. The action of water in causing those corpuscles to swell, and of syrup in causing them to shrink, was very marked, the explanation of this being that a lighter liquid diffuses more rapidly into a heavier one than a heavier into a lighter. This action is known as osmosis. The action of a solution of common salt caused the corpuscles to assume a peculiar crenated or spinose appearance, a form often assumed by red corpuscles after leaving the body in certain conditions of the blood, when they may be mistaken for white ones. A drop of human blood placed upon the slide for some little time and then examined showed radiating structure of fibres which really forms from the blood plasma, and is known as fibrin. This network held the corpuscles in its meshes, and thus the cause of the formation of a blood clot was to some extent observed. Another drop, to which a little common salt had been added, remained liquid, and no such network of fibrin was formed, illustrating the use of certain salts in preventing the coagulation or clotting of the blood, which, under normal conditions, always takes place when it leaves a healthy blood-vessel. * * *

Speaking of the contents of the red blood corpuscles, they were described as consisting of 90 per cent. of the peculiar form of protoplasm know as hæmoglobin diffused through the rest of the corpuscle, the stroma. It was shown that this hæmoglobin could be extracted from blood corpuscles and even crystallized, a preparation of such crystals being projected upon the screen by the oxyhydrogen microscope. It was also shown that these hæmoglobin crystals could be dissolved in water and in blood serum, so that it may be inferred that the non-solution of the hæmoglobin of the corpuscles in the blood itself must be prevented by some peculiar property of the stroma through which it is diffused. The rapidity with which a solution of hæmoglobin could absorb oxygen and lose it again was exhibited by projecting upon the screen the spectrum of a hæmoglobin solution that had been shaken up with air, when two dark absorption bands were visible in the green sep-

*From report in *English Mechanic* of a meeting of the Manchester Microscopical Society.

arated by a bright green line. Upon the addition of a drop of a reducing agent the character of the spectrum was immediately changed—the two absorption bands became merged into one broad one ; but upon shaking up the solution again with air, the former spectrum and bands immediately reappeared. This experiment tended to show that the taking up of the oxygen was the result of chemical combination, and not of mere absorption ; or, in other words, that in scarlet arterial blood the hæmoglobin exists in the form of oxyhæmoglobin, and in the dark-brown venous blood it is the presence of reduced hæmoglobin that gives the characteristic color.

Pedesis (Brownian Movement).*

By Prof. H. M. WHELPLEY.

st. louis, mo.

In 1827 an English physician and microscopist, by the name of Robert Brown, described a peculiar motion of certain fine powders when suspended in liquids. Under favorable circumstances he found that the smaller particles would oscillate in a manner suggestive of vital force. The doctor was not the first person to observe this phenomenon, but he wrote so much about it that it has since been quite generally known as the 'Brownian Movement.' It has also been called the Brunonian movement, pedesis, non-vital motion, and molecular movement. Prof. Donders, of Leyden, was the first to observe and record the movement.

It occurs, according to references, when any of the following powders are suspended in water:—carmine, vermilion, cobalt, wood charcoal, indigo, camboge, pumice stone, carbonate of lead (flake white), glass; also in the crystals of the carbonate of lime that occur near the base of the spinal nerves of a frog, the crystals from the iris of fish, certain of the phosphates in urine, the fat globules in milk, etc. I have not examined all of the crystals referred to, but, in addition to the list of powders, I have experimented with prepared chalk, Prussian blue, Paris green, subnitrate of bismuth, oxide of zinc, precipitated phosphate of lime, oxide of magnesium, calomel, and carbonate of zinc. I have specimens of the powders for inspection. Carmine gives the most satisfactory results, although both Prussian blue and Paris green are very active when first mixed with water. I found it difficult to observe the movement of the fat globules in milk or cream.

The cause of the motion is not known, and, in fact, very little has been said or written about it. Most authors refer very briefly, if at all, to the phenomenon. Among the proposed explanations are currents in the liquids caused by evaporation, changes of temperature, light, electricity, the effect produced by being confined between two glasses (a very indefinite reason), etc. Each one of these theories has been contradicted. Where so many differ it is not wise to put forth any great claim, but my observations lead me to the opinion that perhaps the heat produced by the light from the mirror causes small currents that produce the motion.

In order to observe the movement, all that is necessary is to mix the powder with about 100 times its volume of water, and allow it to stand until all the coarser particles have subsided. With a pipette place a drop of the supernatant liquid on a slide and cover with a thin cover glass. Examine with an $\frac{1}{5}$ inch or higher power objective. It is quite necessary that the slide, cover glass, objective, and ocular all be perfectly clean. I find that the motion is not simply an oscillation on one plane, but the particles move up and down, as is shown by the changing of focus as they move.

* Abstract of a paper read before the St. Louis Club of Microscopists, June 5, 1888.

The motion has been confounded by some writers with the circulation of protoplasm in the cells of organic matter. One authority speaks of having seen it in the threads of sarcode projecting from the apertures in foraminiferal shells. Another considers it to be identical with the movement of the granules in saliva corpuscles. These are merely examples of what foolish statements find their way into standard text and reference books. Some claim that the motion ceases after a short time, while one man reports a mount made six years ago in which the particles are as lively as ever. I have not examined it a sufficient length of time to speak authoritatively on this point.

It is claimed by some that those substances that can be very finely subdivided are the ones that show the movement most readily. This is evidently only a fancy as some of the most palpable powders are the least active. Some one states that the nearer the specific gravity of the liquid agrees with that of the powder, the more active will be the motion. While I am not prepared to disprove this statement, I have been totally unable to verify it by experimenting with pure water, pure (95%) glycerine, mixtures of glycerine and water, chloroform, alcohol, and ether as vehicles. Water gives the best results of any liquid tried.

This motion should be observed by every microscopist who has sufficiently high magnifying powers to see it. Now that we find everything swarming with bacteria there is a liability of pedesis being mistaken for some new micro-organism.

The polariscope is a valuable accessory when observing the movement in crystals, but it is of no avail with other powders. The parabolic illuminator does not seem to be serviceable in this work. The best results come from oblique reflected light passing through a small diaphragm.

Brevoort has studied the subject as much as any recent investigator. He finds that the fat globules in freshly drawn human milk, secreted at the time of childbirth, are very active, but diminish in 'vitality' as the child grows older.

Permanent mounts to illustrate the phenomenon of pedesis are not difficult to make, provided, however, that the motion does not cease after a few days, as claimed by some authorities. I have no reason for doubting the statement of one writer who says he has a mount six years old that shows the movement nicely and as well as it ever did. I place a well-cleaned slide on the turn-table and run a ring of cement on it about 0.5 mm. ($\frac{1}{50}$ inch) high. This warm weather, or in a warm room during winter, the cement will become sufficiently dry in a half hour to permit of finishing the mount. I accomplish this by placing a large drop of the liquid, prepared as directed above, in the cell, and placing in position a well cleaned cover glass. When the cover is pressed down, the superfluous liquid will be pressed out and the fresh cement will hold the cover firmly to the cell. The pressure reduces the depth of the cell to about 0.25 mm. ($\frac{1}{100}$ inch). The slide should be washed to remove any particles of the powder that may have run out with the liquid and been deposited on the cover glass. When dried it is ready for use, and such a mount, at least as far as the mechanical part is concerned, will last a lifetime. Either white zinc cement or Brunswick black can be used.

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REPORTS OF RECENT ARTICLES.

Structure of Lamellibranch Muscle.*—Dr. R. Blanchard has studied the histology of muscle fibres in the lamellibranchs and illustrates with numerous wood-cuts:—1. Observations, which confirm those of Barrois and Tourneux of muscle fibres striated obliquely from the adductor muscles. 2. In *Mytilus maximus* from the adductor muscle spindle-shaped cells with longitudinal striation and an ovoid granular nucleus bordered at each end by a very distinct tapering granular cone, which is lost in the longitudinal striæ. The nucleus lies on the border of the cell. 3. In *Ostrea edulis*, var. de cancale in adductor muscle cells similar to those in 2, but much longer, some cells measuring 2 mm. 4. In *Ostrea edulis*, var. de Marennes the adductor muscle contains some elongate cells with very peculiar oblique striation in various patterns. Some are with two oblique striæ crossing each other, while others have oblique lines which run toward each other and meet and stop in the centre of the cell. The nucleus here is also marginal and the cell fusiform. 5. In *Gryphæa angulata* cells from the adductor muscle have the surface marked with oblique striæ of various direction, producing zig-zag or undulating lines. Forms from other animals are also described, but they are not very unlike some of those already mentioned.

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Remarks on Hydra.—Prof. Leidy remarked, at the Academy of Natural Science in Philadelphia, that in our fresh waters there occur two well-marked species of hydra, the one of a bright green color, the other pale brownish or reddish. These, judging from the descriptions and figures, appear to him to be the same as the European species *H. viridis* and *H. fusca*. The late Prof. L. Agassiz regarded them as different and named them *H. gracilis* and *H. carnea*. Familiar as he was with both the European and American animals, his opinion might be considered conclusive, but the only distinctive character he assigns to each seems not to be correct. Of our green hydra he observes that, unlike the European, it has the power of extending its body in a remarkable degree. Opposed to this view, Rösel, in 1755, represents *H. viridis* in the same condition and with the arms in the same proportionately short state. In other characters, the speaker found our green Hydra to accord with *H. viridis;* and, further, in respect to the sexual organs. Prof. Allen Thompson describes the latter as producing a single ovary near the middle of the body and two or three spermaries from the body just below the arms. The same condition he had observed in our green hydra. As regards our brown hydra, Agassiz gives, as the distinctive character, that it has very short arms, while the European has long ones. Ordinarily, this appears to be the case, but on several occasions the speaker had observed our brown hydra, after it had been kept some time in an aquarium where there was comparatively little food, elongate its arms, extremely attenuated, even to a length of three inches.

He had the opportunity of seeing both the green and brown hydra west of the Rocky mountains, and these he found to accord in character with our

* *Bulletin de la Société Zool. de France*, 1888, p. 75.

Eastern forms. In specimens collected in a lake in the Uinta mountains, Wyoming Territory, at 10,000 feet elevation, the brown hydra at first was brick red, with a brighter red head, but, after keeping it for a week, it assumed the pale brown hue as ordinarily observed in the animal nearer home.

The characters of the two American forms, as observed by him, are as follows:—

Hydra viridis? The green hydra. Animal bright grass green, sometimes paler. Body, when moderately elongated, cylindro-conical, tapering towards the caudal end; when contracted, oval or spheroid; when greatly extended, linear cylindrical. Head conical. Arms, four to seven, commonly six, about half the length of the body, linear, capable of extension to about the length of the body, or slightly more. In the sexually mature state:—Testes hemispherical, surmounted by a nipple-shaped prominence, situated on the sides of the body just below the arms; ovary single, projecting from near the middle of the body, and containing a single, spherical, white egg, enclosed in a brownish covering. Animal usually three or four lines long, capable of extension to twice the length, or contracting to less than a line. In ponds and ditches in the vicinity of Philadelphia and other places, though not common. Observed on one occasion in the sexually mature condition late in autumn. In the individuals observed the sexes were separate; the males with the two testes, and the female with a single ovary. The ovum measured 0.375mm. in diameter. In the sexually mature *H. viridis*, observed by Prof. A. Thompson, individuals were hemaphrodite, while in others the sexes were separate.

Hydra fusca? The brown hydra. Animal more robust than the former, of the same shape and number of arms, but with the body less attenuated when extended, and with the arms habitually longer in proportion to the body, but capable of extension to six times the length of the latter. Color usually pale brownish, or reddish; sometimes deeper, sometimes paler. In ponds, and common on the under side of stones in the Schuylkill and Delaware rivers, in the vicinity of Philadelphia. Not observed in the sexually mature condition. The color of the animal in a measure appears to depend on the nature of the food; and it may become a bright red, of variable tint, by feeding on similar colored entomostraca, or insect larvæ. From prolonged abstinence the color fades and the animal becomes almost white.—*Proc. Acad. Sci. Phil.*

The Black Spot.*

By W. S. WINDLE.

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During the past few years much attention has been paid by florists to a disease of the rose known as the 'rose-leaf spot' or 'black spot.' Upon close examination it is ascertained to be a fungus, and is termed *Actinonema rosæ*. Apart from its scientific interest this spot claims special attention, since it produces a premature falling off of the leaves, especially of the cultivated varieties. The growth of the fungus is most rapid during the cold and moist weather of autumn. It thus becomes very annoying, for, owing to the early falling of the leaves, the rose goes into a premature rest. Often when the cool and moist weather continues young sprouts are put out from the upper buds of the twigs and perish in the winter.

In its early stage this fungus has a characteristic appearance. It first ap-

* Reprinted from the *American Florist*, vol. iii, No. 66, May 1, 1888, to which journal we owe the use of the figures.

pears as a small dark brown or black spot, growing upon the upper surface of the leaf, as shown in Fig. 1, at *a*.

FIG. 1.

It grows rapidly, spreading into the surrounding tissue in a dendritic manner, until the greater part of the leaf has become infested. A pale-yellow zone surrounds the spot, and, as the fungus develops, the zone increases, until all that part of the leaf not occupied by the fungus has assumed the yellow tinge. Upon making a vertical section of the leaf and placing it under high magnifying power, much may be ascertained concerning the true nature of the disease. The fungus is found to lie upon the epidermis, immediately underneath the cuticle. The mycelium of the young plant, by rapid growth, forms a stratum or layer in this part of the leaf. At various points in this stratum, the spores or reproductive bodies are developed from the mycelium. They push upward in a mass against the cuticle, which soon bursts and rolls back, forming a minute ragged cup, as in Fig. 2. Many of these minute cups upon the blackened surface of the leaf cause it to present a roughened appearance.

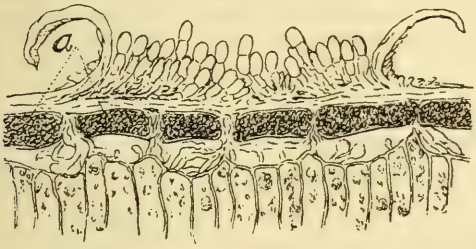

FIG. 2.

Shortly after reaching the surface, the spores become detached and are transported by the wind or other agents to neighboring rose leaves, where they soon germinate, and thus the disease is rapidly spread. The spores are very minute in their structure, appearing to the naked eye as dust particles. Magnified five or six hundred diameters they are shown to be oblong bodies, constricted in the middle, and are divided into two cells by a transverse partition. Fig. 3 represents these spores as they appear under the microscope.

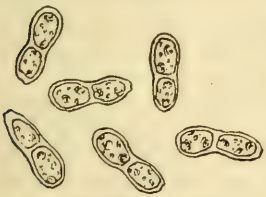
FIG. 3.

From the layer of mycelium, lying between the cuticle and epidermis, short branches (hyphæ) are sent down between the outer epidermal cells into the tissues of the leaf, from which the fungus derives its nourishment. Thus far nothing definite has been determined concerning the character of this mycelium and the extent to which its hyphæ ramify through the leaf tissues.

The blackening of the leaf does not originate from any coloring matter in the fungus, but is due to an abnormal growth in the epidermis. The epidermal cells of a mature rose leaf are divided by tangential partitions into two, an inner and an outer cell. In the healthy, growing leaf these cells are filled, mainly with protoplasm, chlorphyll granules, and cell sap, the outer epidermal cell containing the greater amount of substance. As soon as the fungus begins its growth, the character and appearance of the contents in the outer epidermal cells at once begin to change, while that of the inner cell is not perceptibly affected. It very rapidly assumes the appearance of a dark brown granular pigment which entirely fills the cell. This substance gives the dark color to the 'black spot.' Fig. 2, *a*, illustrates this growth.

Judging from its chemical reactions, its general composition, its position in the tissues of the leaf and the circumstances of its production, the assertion may be made with a good degree of certainty that this 'pigment' is an abnormal growth from the cell-contents in the outer epidermal cells, and is induced by the action of the fungus upon this tissue of the leaf. The yellow color around the black spots is due to the death of the tissues and the breaking down of their cell contents.

Thus far all attempts to eradicate this disease, without permanently injuring the rose plant, have been futile. Being very tenacious of life, it resists the attacks of all the more common fungicides. To keep a warm dry atmosphere, not below 70° F., about those varieties which are most easily attacked by the disease, has been found a good preventative. It has been ascertained by experiment that the fungus attacks those roses most readily which are growing in very rich, damp soil. From this it is inferred that the disease may be prevented to some extent by placing the plants in a moderately poor soil, and furnishing them with only a sufficient amount of water for growth. A German writer, Sorauer, has suggested that, to prevent the spread of the disease, all those leaves affected should be removed and destroyed as quickly as the spots appeared upon them. There is yet much to be done in the way of discovering a cure for this most fatal disease known to the rose.

Notices of New Methods.—V.

By GEORGE C. FREEBORN, M. D.,

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Alcoholic Solution of Hæmatoxylin. G. Cuccati.*—Dissolve 25 gms. of chemically pure potassium iodide in 25 c.c. of distilled water. Pour this into a bottle and add 75 c.c. of absolute alcohol, with constant agitation; then cork tightly. Grind up in a mortar 0.95 gms. of hæmatoxylin crystals and 6 gms. of chemically pure alum. Then add, little by little, with constant stirring, the potassium iodide solution, and finally return the mixture to the bottle. Allow it to stand from ten to fifteen hours, shaking occasionally. At the end of this time filter through paper, taking precautions for the prevention of the evaporation of the alcohol, and preserve in a well stoppered bottle.

This solution stains with sufficient intensity, but not beyond a certain limit.

Osmic Acid Method. A. Kolossow.†—In order to increase the power of penetration of this reagent various acids have been combined with it. Kultschitzky used formic acid, Cybulsky acetic acid, Cattaneo arsenic acid. The use of these acids produce artificial changes in the tissues. In place of these acids the author uses the acid salts of uranium nitrate or acetate.

The solution recommended by him is as follows:—To a 2 or 3% solution of either uranium nitrate or acetate ½% of osmic acid is added. Large objects [frog's lung] are divided transversely into two or three parts and placed in the above solution, where they are allowed to remain, according to the stain wanted, for a longer or shorter time [16, 24, 48 hours]. This solution does not make the tissues brittle.

The osmic acid stains the myelin black and the remainder of the tissues are fairly well fixed.

Gold Chloride Method. A. Kolossow.‡—The objects are placed in a 1% solution of auric chloride for 2, 3, or more hours, until they are soaked

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* Zeitsch. f. Wiss. Mikros. v, 1888, p 55.
† Zeitsch. f. Wiss. Mikros. v, 1888, p. 50.
‡ Zeitsch. f. Wiss. Mikros. v, 1888, p. 52.

through. Then, after washing slightly in water, they are placed in a 1-50 or 1-100% solution of chromic acid 2 to 3 days in the dark, for the reduction of the gold. Sometimes the reduction is not completed at the end of this time, but becomes so in the clearing and mounting in balsam. The more thoroughly the chromic acid is washed out of the sections the sharper the pictures will be.

The non-medullated nerve fibres, to their finest ramifications, are stained black; the connective tissue cells stand out sharply, the intercellular tissue remains unstained. Striated and smooth muscle take a greenish shade.

Carmine for staining in toto. E. Aievoli.*—To 100 c.c. of hot water add 1 gm. of powdered carmine. When it has become diffused through the water add 7 gms. of natrium phenatum. The mixture is kept at a moderate heat for 30 to 40 minutes, with stirring, and then filtered.

Bits of tissue are placed in this fluid for 20 to 24 hours, then in acidulated (1%) alcohol for an hour. This gives an intense and clear nuclei stain.

Modification of Heidenhain's Hæmatoxylin Method. Stephan Apathy.†—The author makes a 1% solution of hæmatoxylin in 75 to 80% alcohol and a solution of potassium bichromate of the same strength and in the same medium. As the potassium bichromate is but slightly soluble in alcohol he uses a 5% solution of this salt in water and dilutes 1 part of this with 4 parts of 80 to 90% alcohol. The last solution is to be kept in the dark, as in the light the chrome salts are precipitated.

The time required for staining depends upon the size and penetrability of the object. If the object be overstained with the hæmatoxylin, it will require a longer time for the action of the chrome salts. For thin sections (10–15μ) one allows the chrome salts to act for half as long as the hæmatoxylin; for thicker sections (25 to 40μ) twice as long. The solution of potassium bichromate should be renewed at least once. After the completion of the action of the chrome salt, the sections are washed in 70% alcohol, which should be renewed several times, then placed in 90% alcohol and finally in absolute alcohol. A good washing in alcohol, in the dark, for many days prevents the precipitation of the salts in the tissues.

Pyridine in Histology. De Souza.‡—As pyridine, neutral in reaction, coagulates albuminates it is a useful reagent for hardening animal tissues. It is also miscible with oils, fats, and water, and offers certain advantages, if the solution of the fat is not taken into consideration.

In the warm oven it hardens small animals in eight days. The form is well preserved, and at the same time the tissues are hardened, dehydrated and cleared. After hardening the tissues cut easily and stain well with any of the aniline dyes. The sections are mounted in balsam, or after washing in water they may be stained in picro-carmine or hæmatoxylin.

Phenol in Microscopical Technique. A. Aievoli.§—To prevent the rolling in cutting of paraffin imbedded objects various forms of section smoothers have been devised. In order to do away with these the author advises the following manipulation:—The paraffin imbedded object is cut and the sections allowed to roll up. They are then placed in benzine or turpentine for 20 minutes; then they are transferred to pure phenol. In this the sections unroll and float on the surface.

Writing on Celloidin Blocks. Apathy, S.‖—Blocks of celloidin can be labelled, if the characters are written, with a soft lead pencil on the bot-

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* Rivista Internaz. di Med. e Chirurg. Napoli, iv., pp. 102–104.
† Zeitsch. f. Wiss. Mikros., v, 1888, p. 47.
‡ Comptes rend. hebd. de la Soc. de Biol., iv, p. 622.
§ Zeitsch. f. Wiss. Mikros., v. 1888, p. 66.
‖ Zeitsch. f. Wiss. Mikros., v. 1888, p. 46.

tom of the paper imbedding box in which the object has already been placed, before the film has formed on the surface of the celloidin. When the paper is removed from the hardened celloidin, the writing will be found transferred to the bottom of the block. It is now painted over with a thin layer of celloidin to fix it.

EDITORIAL.

The new marine biological laboratory at Wood's Holl is for the continuation of the work of the laboratory heretofore located at Annisquam, Mass., and which has done so well under the direction of Prof. Alpheus Hyatt during the past six years. The newly organized laboratory is designed to furnish a place where anyone who desires the inestimable advantage of seashore work in biology can find every opportunity for it. Similar facilities have been afforded by the Annisquam laboratory, by the laboratory of the Fish Commission, and by the Chesapeake laboratory. We have little doubt but that this laboratory will be well patronized by elementary students, and trust that the laboratory for investigators may also prove successful. The direction of Prof. C. O. Whitman and the instruction of Prof. B. H. VanVleck insure any who attend everything needed in the way of guidance and supervision. Teachers seeking a place for work can scarcely do better.

It is hardly necessary to write of the benefits to zoölogists of seaside study. All know that many representative animals, such as the ascidians and echinoderms, are not found in fresh waters. But more important than that, since the preserved specimens may be carried inland, is the great advantage of handling live specimens—to see them live and move, to dissect them fresh (often more advantageous), and to preserve them by various methods, observing the changes produced by the treatment. This remark applies to the beginner; the expert knows too well to require mention the necessity, for original studies in many groups, of a residence on the shore.

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Darwin's biography.—Any of our readers, who have nót already done so, should lose no opportunity of reading Darwin's Life and Letters recently issued. We can conceive of no honest and intelligent person, whatever his estimation of Darwin's philosophic attitude, who would not thoroughly enjoy reading such a charming revelation of the personality of this great man. There can be no question of the wonderful interest and following which his views have received, and attention enough was bestowed upon the man to have spoiled a weaker character without in the least marring the beautiful simplicity of *his* character. No theme would give us greater pleasure on which to write at length than these two volumes, and their story—the Boy at College, the Explorer of the Beagle, who, in spite of bodily weakness, was so active in seeing everything, the era during which the idea of the 'origin of species' was dawning and growing, filled with the uninteresting task of finishing up the results of his Beagle studies, the modest feeling which prompted him to withhold his work from publication and allow the laurel of discoverer of the great idea to be another's, the honest and whole-souled enjoyment he had in the success of his brethren, the entire absence of envy—these and many more evidences of a beautiful character must charm anyone who comes under the influence of the biography, even if he regarded Darwin as under a great delusion. And to the worker in science the book must have an especial charm, for it shows such wonderful patience and industry in spite of difficulties which, to most minds, would have been insurmountable.

The Journal.—In the leading editorial of December last, it was announced that Mr. C. W. Smiley had been admitted to an intererst in this JOURNAL. Negotiations then in progress have resulted in transferring to him its entire ownership. He assumes all assets and liabilities dating since January 1, 1887. The business has been exclusively in his hands for nearly a year, he having done much more than he was willing to have appear. The JOURNAL retains the friendship and good wishes of its founder, who expects still to contribute to its columns. We hope that our patrons will always feel an interest in his work and be glad to hear of his successes.

NOTES.

Dr. C. R. Agnew.—At the last meeting of the Ophthalmological and Otological Section of the New York Academy of Medicine it was voted:—

'That a committee be appointed, of which the chairman of the Section, Dr. David Webster, be a member, whose duty it shall be to obtain a good photograph of the late Dr. Cornelius R. Agnew, for the purpose of having engravings suitable for framing made. The right of issue and sale of such engravings shall be given to some first-class publisher, if practicable; if not, the committee shall offer them to the profession at cost.'

In accordance therewith a committee has been appointed. Members of the profession who desire such an engraving, accompanied by an autograph signature, should send their names and addresses to the secretary of the committee, Dr. Charles H. May, 640 Madison Avenue, New York city, at once. When all such names shall have been recorded, those who have requested a copy of the engraving will be notified of the cost of the same, either by the publisher or by the committee having the matter in charge.

Meeting of the American Society of Microscopists.—Upon invitation of the State Microscopical Society of Ohio the 11th Annual Meeting will be held in Columbus, Ohio, beginning August ~~14th~~, and lasting four days. It may reasonably be expected that the number of members attending the coming reunion will exceed that of past years. There are more members than ever before; the place of gathering is central, attractive, and a university city, one which affords all conveniences and facilities that can be desired for entertainment. Thorough preparation will be made to receive all who may attend. The American Association for the Advancement of Science meets the following week in Cleveland, Ohio, making it convenient for many who desire to attend both; and there is manifestly a growing and abiding interest in the work of the Society. Some interest also attaches to the fact that this completes ten years of existence as an organization, and it is hoped that as many as possible of the forty-nine who took part in the initial meeting at Indianapolis will be present that they may be honored by the Society.

The President, D. S. Kellicott, of Buffalo, N. Y., exhorts those interested not only to be present, but to furnish the best and choicest work in hand, the results of investigation, experience, or invention, that are additions to science. Aside from the educational value the meetings afford, which is admitted to be considerable, the publications are the foundation and chief reason for the Society's being. The proceedings of the Society should be its pride, in style, accuracy of text, and illustrations, as well as in matter of the highest order attainable under the circumstances. To issue the memoirs in proper form requires and receives the whole income of the Society. In order that the next volume may go to press soon after adjournment, it is desired that writers shall complete their manuscripts and drawings so that they may be left with the Secretary at Columbus.

Practical work of demonstration has been a valuable feature of the annual gatherings since the Chicago meeting in 1883. This year more time than heretofore will be thus devoted. The Society at Pittsburgh directed the Secretary to provide, if possible, a demonstration for each session, in addition to the usual working session occurring on Thursday afternoon of the week of meeting. The Committee on Working Session is C. C. Mellor, Pittsburgh; T. B. Stowell, Cortland, N. Y., and A. M. Bleile, Columbus.

Blanks for communicating titles of papers and nominations of members may be had if desired by addressing the Secretary, Professor Thos. J. Burrill, Ph. D., Cham-

paign, Ill. A circular giving specific information regarding railway fares, hotel rates, etc., will be issued by the Secretary in July.

The New Marine Biological Laboratory.—The new laboratory is at Wood's Holl, Massachusetts. A convenient site has been secured close to the shore and to the laboratories of the United States Fish Commission. The laboratory building consists of two stories, the lower story for the use of students receiving instruction, the upper story exclusively for investigators. The laboratory will have boats, dredges, and other collecting apparatus; it will also be supplied with running sea-water, with alcohol, and other reagents, glassware, microtomes, aquaria, etc., a limited number of microscopes for students' use, and a small reference library.

The laboratory for students will be opened on Tuesday, July 17th, at 9 A. M., for a systematic course of six weeks in zoölogy. By permission of the director students may continue their work until September 20th without additional payment. Microscopes, glassware, etc., will be supplied without extra charge, except for breakage. Hand lenses, dissecting instruments, drawing materials, etc., may be bought at cost in the laboratory. It is desired that students owning microscopes should bring them. The fee for this course is twenty-five dollars, payable in advance. The number of students will be limited to twenty-five.

The laboratory for investigators will be opened on July 10th, and will be closed on September 22d. It will be equipped as fully as the means permit. Microscopes will not be provided, but it is believed that investigators will find most of their indispensable wants satisfied. The fee for an investigator's table will be fifty dollars for the present season.

Rooms accommodating two persons may be obtained near the laboratory at prices varying from $3.00 to $4.00 a week, and board from $4.50 to $7.00. Applications for places in the laboratory should be made *immediately* to the 'Secretary of the Marine Biological Laboratory, Nahant, Mass.' Wood's Holl, owing to the richness of the marine life in the neighboring waters, offers exceptional advantages. It is situated on the north shore of Vineyard Sound, at the entrance to Buzzard's Bay, and may be reached by the Old Colony Railroad (2½ hours from Boston), or by rail and boat from Fall River and New Bedford. Persons coming by the way of Boston should buy round-trip tickets ($2.85).

American Association.—The thirty-seventh meeting of the American Association for the Advancement of Science will be held at Cleveland, Ohio, beginning Wednesday morning, August 15, and lasting until Tuesday evening, August 21. By vote of the Association at the New York meeting, Cleveland was fixed upon as the place of meeting for 1888. Owing to the national gathering of the Knights Templars in Cleveland, and at the earnest solicitations of the local committee, the Council have changed the date to August 15.

A special office and reception rooms for the Association have been opened at No. 407 Superior street, next door to the Hollenden, where will be the hotel headquarters. The meetings will be held in the Central High-School Building on Wilson Avenue, where, also, will be the offices of the local committee, and of the Permanent Secretary during the week of the meeting. Board may be had at moderate rates in various hotels and boarding-houses within easy reach of the High-School Building, and, as the ladies of the local committee will provide a lunch in the building, members will not be obliged to leave the building during the heat of the day.

A special circular in relation to railroads, hotels, and other matters will be issued by the local committee, and members who are about changing their address for the summer should notify the local secretary at once. It can now be stated, however, that arrangements have been made by Mr. Dudley and the Special Committee on Transportation by which members and their families will generally be able to obtain return tickets for one-third the regular rate. It is probable that all the railroads will insist upon the three-day limit *before* the meeting for the sale of tickets with certificates securing reduced return rates. Arrangements for excursions and receptions will be announced by the local committee.

For all matters pertaining to membership, papers, and business of the Association, address the Permanent Secretary, at Salem, Mass., up to August 9. From August 9 until August 22, his address will be 407 Superior St., Cleveland, Ohio.

A compass plant.—An extraordinary plant is said to grow wild in the States of Oregon and Texas, the leaves of which point due north and south. If so, it can be utilized

by travellers as convenient substitutes for the magnetic needle. It is a dwarf variety of the osier, named *Sylphium laciniatum*. It is a perennial, and attains a maximum height of 3 feet 6 inches. The peculiar propensity of its foliage is attributed to the fact that both surfaces of its leaves display an equal receptivity for light. All the other known varieties of *Sylphium* are characterized by the presence, on the lower surface of the leaves, of from two to three times as many respiratory vessels as are contained in the upper surface, which is, therefore, the more sensitive of the two to light influences. But both surfaces of the *laciniatum* are clothed alike with an epidermis exceptionally receptive of light. According to Professor Meehan, who reports these facts, the same instinct of its leaves that prompts them to require an equal distribution of light upon their surfaces causes them to assume a vertical position, and to point due north and south—one flat of each leaf thus facing the east and the other the west.

We learn that the Pathological materials in the Army Medical Museum, at Washington, are to be thoroughly catalogued. Also, that illustrations and histological studies by photograph and otherwise are to be made from the subjects. This would make a most thorough and valuable text-book.

Medical anatomy.—The *St. Louis Medical and Surgical Journal*, in a review of the new edition of Gray's Anatomy, recently published, announces an excellent principle.

'Gray's Anatomy is sadly deficient in this point, viz:—That the student is not given an introduction as to the relations of the science of anatomy to other sciences, especially to morphology and biology. It seems to us that, at the present time, a physician should be more than merely a practitioner of medicine. He should also be instructed in the scientific foundations of the disciplines which he needs in the practice of his profession. Lacking these, he is a little better than an artisan, and will never be able to reach the noblest aims of his profession.

'It is an undeniable fact that the genetic method of explaining anatomical facts illuminates the process of teaching and learning, and thus not only the memory, but the reasoning powers of the student are exercised. The time has come when the old mnemonic method of learning anatomy can no longer be tolerated. "To teach means to develop." Therefore, there can be no doubt that the genetic method should always work hand in hand with the descriptive. By this means only anatomy has been made a science which stands higher than those pseudo sciences, medicine and surgery.'

The reviewer thoroughly appreciates and commends the work as a manual of human anatomy, assigning it the highest place in this or any language.

MICROSCOPICAL SOCIETIES.

St. Louis Club of Microscopists.—Frank Davis, *Secy.*

At the first annual meeting, May 1, the following officers were elected for the ensuing year:—President, H. M. Whelpley; Vice-President, D. L. Haigh; Secretary, Frank Davis; Treasurer, Wm. Ilhardt; Curator, J. C. Falk. A committee was appointed to purchase a suitable cabinet for the collection of slides. One of the Griffith Club microscopes was shown and admired by all.

'The Microscopical Examination of Honey' was the subject presented by J. C. Falk. He has examined numerous samples, and has been able to distinguish the pollen grains in pure honey, while they are absent in artificial honey, and only sparingly present in adulterated honey. The pollen grains vary considerably in size, but are easily distinguished with a $\frac{1}{10}$ inch objective. The members will examine the honey for sale in St. Louis, and report at the next meeting.

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Essex County, N. J.—F. Vanderpoel, *Secy.*

February 16, 1888.—Mr. W. C. Gardner, of Montclair, read a paper upon the 'Optics of the Microscope,' illustrating the subject by diagrams. Two theories of light have been proposed and advocated, although the undulatory theory has finally been adopted. The immense velocity of light waves was touched upon, and the subjects of reflection and refraction of light explained; also, what are meant by angles of incidence, reflection and refraction, and the index of refraction. This, for crown glass, is 1.5. Total reflection was clearly illustrated by a diagram. The critical angle for crown glass was stated to be 41° 48′. This property of the total reflection of light is

made use of in the Wenham Binocular Prism and Paraboloid, and some other accessories. Dispersion of light and the properties of prisms and lenses were explained, also the similarity of convex and concave lenses to prisms united either by their bases or apexes. This was illustrated by drawings.

Spherical aberration was discussed, and its remedy by means of a diaphragm, with which to cut out the extraneous rays, was mentioned; but, as this causes a great loss of light, it is by no means as good a remedy as that generally adopted—the use of a second lense of different form—a minifying lense to correct a magnifying one. Chromatic aberration was explained by means of diagrams illustrating dispersion by prisms, and, as a matter of course, by lenses, the violet rays being refracted more than the red, and the intermediate colors in the order found in the solar spectrum. A flint-glass prism, as it disperses the rays more than one made of crown glass, can be used to correct the chromatic dispersion of the latter, while at the same time it allows the ray to be refracted out of a straight course, and the same is true of lenses made of these glasses. Up to a recent date, however, the achromatism was not perfect, because the lengths of the corresponding colors in the two spectra were not the same, and there resulted a secondary spectrum. The new glass with which we have lately become somewhat familiar, however, has eliminated this to a remarkable degree, and has rendered the images of objects seen through it almost absolutely colorless. The images produced by lenses, both real and virtual, were explained by diagrams. The next subject was the compound microscope. The passage of the rays of light through the objective and eye-piece was shown, and also the advantage of the field lense.

'Angular aperture' was defined as the 'angular difference between the paths of the most divergent rays which an objective can gather up and bring to a focus.' Dry and immersion lenses received attention, and the advantage of the latter over the former in working distance and use of oblique rays fully explained. Lest there be some misapprehension as to the meaning of what is known as a lens of 180° angular aperture, when this is known to be a straight line perpendicular to the line of vision, Mr. Gardner explained the matter, and said that it was equivalent to a balsam angle of 82°. After the reading of the paper, Messrs. Gardner and Smith showed by the aid of a lantern the action of lenses of different shapes upon pencils of light, the phenomena of refraction and total reflection. The ever beautiful and fascinating experiment of the stream of falling water, which imprisons the light (sent into it) by total reflection from the upper and under surfaces, closed the meeting.

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March 1, 1883.—Meeting held at the residence of Mr. J. L. Smith at West Orange. Mr. Smith had arranged upon a table his fine Powell and Leland stand, with a number of accessories and a drawer filled with slides. He proceeded to explain to the members some of the methods in microscopic manipulation which he had found very useful in laboratory work, and by means of which the best performance of objectives, condensers, etc., could be obtained.

He first explained his method of obtaining axial light with the plane or concave mirror alone. This was done by putting the object upon the stage, placing the mirror as nearly central as possible, throwing the light upon the object, which is in focus, of course, and then racking the tube up and down and noting the shadows, which, when the light is axial, would not be thrown to one side or the other, but remain central. This was demonstrated with a slide of *Arachnoidiscus*. He also stated that when using the mirror the best position for the lamp was on one side, and not in front of the stand. If the observer be in the habit of using his left eye in looking through the tube, the lamp should be on the left side of the latter, as the tube then shields the right eye from the flame. This position is changed when the right eye is used for observation. This side position of the lamp also permits the best sort of reflection from the mirror, and prevents, to a great extent, the formation of double images (*i. e.*, from the silvered back of the mirror and from the surface of the glass).

The next operation was that of centering the substage condenser to high powers. This is done as follows:—First put on the high power, having upon the stage any familiar object, such as a diatom, which could afterwards be readily recognized in the field of a lower power objective, *e. g.*, an inch. Bring the diatom into the centre of the field of the high-power objective (say $\frac{1}{12}''$). Now remove the twelfth, and, *without touching the slide*, put on the one-inch; focus down to the slide, and note the position of the diatom, which will almost certainly be a little off from the centre of the field of the one-inch. (It is, however, still in the centre of the field of the $\frac{1}{12}''$.) Now, with the 1″ still on, centre the condenser *to the object* by noticing the images of the

smallest diaphragm with which the condenser is supplied. By using a diaphragm below the condenser its image and the object can be brought into focus at the same time. Focus on the object, and then rack up the condenser until the diaphragm is clearly seen. Then, when you remove the 1″ and replace the $\frac{1}{12}$″, you will find that the latter has the light central, and can be used for the examination of any object requiring central light with this objective. The difference between the illumination with the plane or concave mirror alone and that with the achromatic condenser was next shown by the effect upon a scale of *Podura plumbea*. With the condenser the light could be much more easily modified, while at the same time it was kept central and the markings much more clearly defined.

The advantage of using small diaphragms instead of large ones with the Abbé condenser was next shown, the object viewed being an *Arachnoidiscus Ehrenbergii*.

Wenham's reflex illuminator was also shown in the resolution of *Amph. pellue.* with a Bausch & Lomb $\frac{1}{8}$″ homogeneous immersion objective and $\frac{1}{4}$″ eye-piece, magnifying 3200 diameters; also with $\frac{1}{8}$″ eye-piece (6400 diameters). This gives more light than any other oblique illuminator, and, when once mastered, is the quickest.

Beck's vertical illuminator for high powers was next shown, but the result was not quite so satisfactory as the other performances, Mr. Smith stating that in order to obtain the best results the lens should be a wide-angled homogeneous immersion, the object mounted dry on the cover-glass, and that a small movable diaphragm be used to modify the light, the smaller the stop the better. The opening used in this instance was $\frac{1}{64}$″

Dark field illumination was obtained with Zentmayer's form of the Abbé condenser, the smallest stop being used. Mr. Smith considered this form of condenser the best that he had ever seen, far surpassing the ordinary paraboloid in sharpness, amount of light, etc.

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March 22, 1888.—Meeting held at the residence of Dr. Wm. B. Berry, Montclair. Dr. Chambers showed a bicuspid tooth capped with gold, and which had been extracted on account of an abscess forming in the jaw. Dr. Allan made some remarks on the methods of capping teeth, and said it was important that the band around the neck of the tooth should not reach too far down, as it was liable to produce inflammation in the peridentium. With permission of Dr. Chambers the tooth was broken, and it was found that the pulp chamber had not been cleaned and filled.

Dr. Berry showed a fine specimen of tattooed skin taken from the arm of a sailor. Dr. Brown exhibited mounted specimens of chancre and chancroids, and Mr. Woolman presented some fine polariscope objects.

NOTICES OF BOOKS.

Observations on the Embryology of Insects and Arachnids. By Adam Todd Bruce. Baltimore, 1887. pp. 31; plates i–vi.

The quarto volume before us is the Doctor's thesis, and its interest arises both from the intrinsic value of its contents and because it is the last of the author's scientific work. It contains a brief introductory sketch of Dr. W. K. Brooks, reviewing Dr. Bruce's life and work, followed by the text of the thesis itself. The forms studied to furnish a basis for the paper were *Thyridopteryx*, *Chrysopa*, *Meloe*, *Mantis* and *Musca*, and an undetermined spider. The results of the embryological studies for the general classification of tracheates are briefly as follows:—Peripatus and myriapods from the absence of wings may be regarded as very primitive members of the group; peripatus and the spiders are similar in the mode of origin of the germinal layers, but this alone does not indicate close relationship; embryological characters not alone sufficient to separate the arthropod phylum. Arachnids with Limulus must be regarded as a distinct group because of the entire absence of antennæ; the antennæ of insects and crustacea are probably homologous structures; the amnion of insects and arachnids are homologous and ally those groups; the insects thus stand between crustacea and arachnids, and the three groups are none derived from the other, but more likely all are from a common source; the tracheæ of insects and spiders are probably analogous and not homologous structures.

From this summary of the results of Dr. Bruce's work the reader can see that a worker of no small promise was lost in the death of its author. Additions of perma-

nent value and suggestions of importance grew out of his work on the arthropods, and from the activity of mind and his perseverance all who knew him were glad to join in the enterprise of publishing his thesis as it left his hands, incomplete though it was. It is not only a memorial to his power, but a contribution of permanent value to science.

The Book of Plant Descriptions, or Record of Plant Analyses. By Geo. G. Groff. Lewisburg, Pa.

The value of recording the results of observations in science study is twofold :—first, by requiring definite statements it sharpens the observations ; and, second, it preserves work done as a permanent possession of the worker. The latter becomes important if he is likely to continue his work at all extensively. The former purpose is alone sufficient to justify the large number and variety of works, tables, etc., of the kind before us. It presents a syllabus of the terms most frequently used in phænoyamic descriptions with brief definitions, suggestions for laboratory work in plant morphology and physiology, blank pages for the exact description of a plant which is being systematically dissected. A very commendable feature of the blanks is the insertion of the word indicating the exact point described before the blank place which the description is to fill. Thus, after anthers we find attachment ——, shape ——, aspect ——, dehiscence ——, No. cells ——, pollen ——. By asking a series of definite questions this brings the student to see in their best order the important anatomical facts. The margin of each page contains blank spaces with names for the reception of drawings illustrating the plan of the flower, the section of the flower, the structure of the stamen, pistil, ovary, etc. Upon the whole we regard the work as one of the most satisfactory we have seen. The binding by means of staples prevents the book from opening flat.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

OFFERED.—Diatomaceous earth from Thibet, various localities (12,000 feet); also, material and slides of diatoms from Scottish Highlands, and continental foraminiferæ. WANTED.—Slides of American diatoms, insects, or botany. W. D. STEWART, 2 Gilmore Terrace, Edinburgh, Scotland.

OFFERED.—Sections of vegetable ivory and slides of crystalized maple sugar. Good mounts taken in exchange. WM. LIGHTON, 106 Fifth Avenue, Leavenworth, Kansas.

WANTED.—Parasites and books on Parasites and other micro. subjects. Will give Anatomical, Pathological, Botanical, Micro-fungi, Zoophytes, Polycistinæ, Foraminifera, Parasites, and other slides in return. FRED. LEE CARTER, Gosforth, near Newcastle-on-Tyne, England.

Wanted, Diatomaceous earth from Mégillanes, Bolivia, South America. Can give in exchange either Diatomaceous earth from New Zealand or cash. E. MICHALEK, I. Fleischemarkt, No. 1, Vienna, Austria.

Mounted sections of Fœtal Lung (5 months), sections across entire lobe, $\frac{1}{2500}$ in. thick, beautifully stained, in exchange for first-class pathological slides. W. C. BORDEN, M. D., U. S. A., Fort Douglas, Utah.

Wanted, earths, recent diatoms, and miscellaneous objects for mounting. Only first-class material offered or desired. MARY A. BOOTH, Longmeadow, Mass.

Fossil Diatomaceous deposits (marine) wanted from Bermuda, Virginia, Maryland, California, etc. I. ELLIOTT, Ardwyn Villa, Aberystwith, Wales, England.

Labels for slides. EUGENE PINCKNEY, Dixon, Ill.

Correspondence relative to exchange in microscopical material or prepared mounts. HENRY L. OSBORN, Hamline, Minn.

First-class Histological Slides for other good mounts ; Histological and Pathological material cut on shares. S. G. SHANKS, M. D., 547 Clinton Ave., Albany, N. Y.

Notices.—All communications for publication should be addressed to Henry Leslie Osborn, Hamline University, Hamline, Minn.

Subscriptions, and all matters of business, should be addressed to Chas. W. Smiley, P. O. Box 630, Washington, D. C.

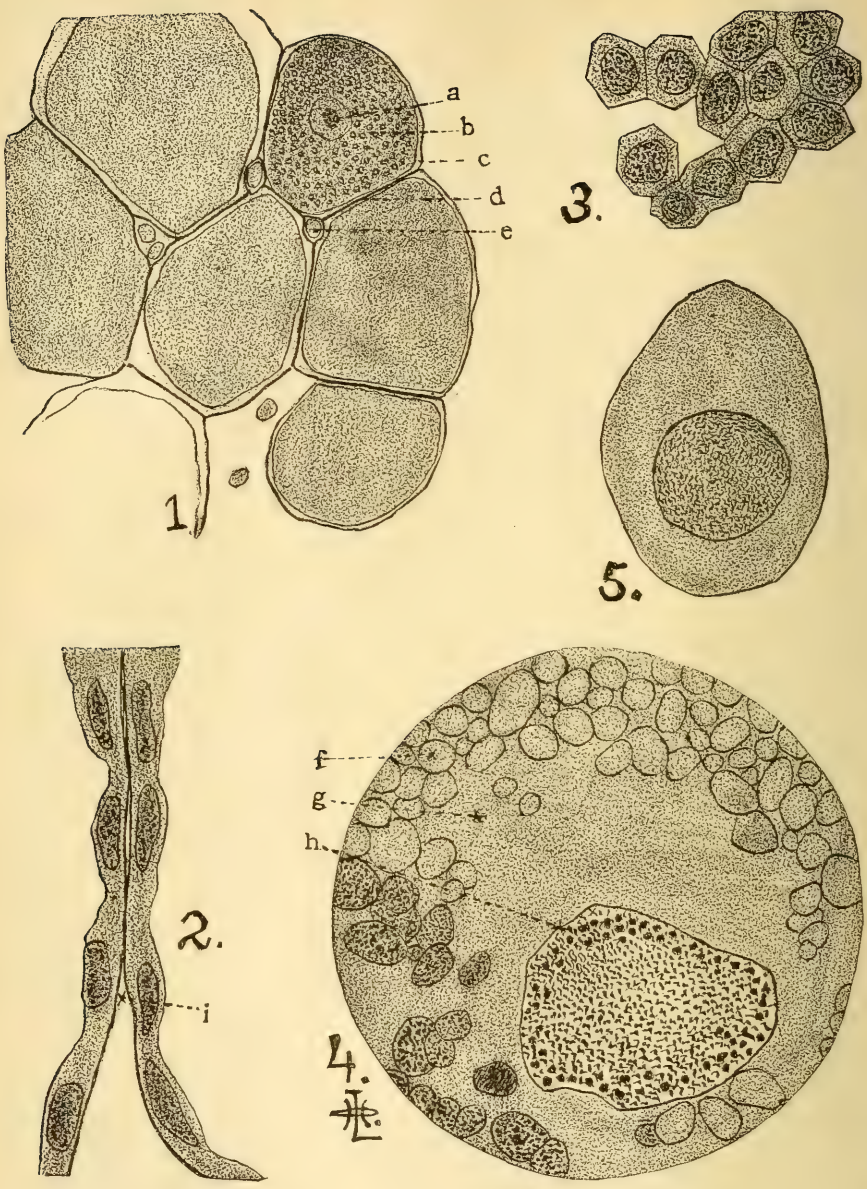
Subscription price $1.00 PER YEAR *strictly in advance. All subscriptions should end with the December number.* A pink wrapper indicates that the subscription has expired. A date on the wrapper indicates the month to which payment has been made.

Orders for slides advertised by A. J. Doherty in the Journals from January to April, 1887, may be sent through P. O. Box 630, Washington, D. C.

A few copies of Leidy's Fresh-Water Rhizopods, of North America, can still be had at $5.00 per copy.—P O. Box 630, Washington, D. C.

Remittances should be made by postal notes, money orders, or by money sent in registered letters. Drafts should be made payable in Washington, New York, Boston, or Philadelphia.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the following prices which are net :—Vol. II (1881) complete, $1.50 ; Vol. III (1882), out of print ; Vol. IV (1883) complete, $1.50 ; Vol. V (1884) complete, $1.50 ; Vol. V (1884), Nos. 2–12, $1.00 ; Vol. VI (1885), $1.50 ; Vol. VII (1886), $1.00 ; Vol. VIII (1887), $1.00. As calls for Volumes I and III sometimes occur, those persons having copies to dispose of would do well to inform us, and to state their prices.



OVARY OF THE CRAY-FISH.

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Elementary histological studies of the Cray-fish.—X.

BY HENRY L. OSBORN.

CHAPTER IV.—THE OVARY.

We have now examined, in this series of elementary studies of animal tissues, the liver and the intestine of the cray-fish. This course of the essentials, if fully understood, may be used as an introduction to further studies of histology, so far as it is pursued, by means of sections. It seems, however, desirable, and has been from the first a part of my purpose in connection with the present series, to make elementary studies of most of the parts of the body of the cray-fish, completing the round of almost all the various organs in the entire anatomy. The usual course of anatomical or physiological study would suggest treating the reproductive system last. To do this, however, is not convenient in the present instance; and the order being of no great importance for the general purpose of my work, I shall depart from it and proceed at once to the examination of the ovary and testes, leaving muscle and nerve, the sense organs and the skin until some later time.

I. Preparation of the section.—In selecting the specimen from which to obtain material for studying the ovary it is necessary to bear in mind that the sexes are separate in these animals, and to learn how to distinguish the males from the females. The shape of the body and the coloring are alike in both sexes, and are hence of no assistance for this purpose. At first sight the observer would imagine the two sexes were not distinguishable, but careful examination of the 'legs' of the abdomen of several specimens will show him that in some those borne on the front rings of the abdomen next the trunk are much larger than they are in others. He can sort all his specimens into two groups, in one group of which he places those whose front abdominal legs are like in shape and size to those behind, while in the other he places those whose front legs differ in both shape and size. The former are females, the latter are males. The enlarged legs are used in the act of copulation to guide the spermatic fluid to the female oviduct. Besides these conspicuous differences between the male and the female there is also a difference in the situation of the opening of the reproductive organs. In the females these are on the basal joint of the thoracic leg, third from the last on each side, while in the male they are on the basal joint of the last thoracic leg on each side.

EXPLANATION OF THE PLATE.

Fig. 1.—General view of ovary with eggs.
Fig. 2.—Enlarged view of wall of follicle at point *d*.
Fig. 3.—Surface view of follicle wall.
Fig. 4 —Enlarged view of centre of one egg.
Fig. 5.—Immature egg.
a. Nucleus of mature egg.
b. Yolk globules.
c. Space between egg and wall of follicle.
d. Wall of follicle.
e. Immature egg in position in ovary.
f. Yolk globules enlarged.
g. Protoplasm of mature egg.
h. Nucleus or germinal vesicle of mature egg.

A third peculiarity by which the sexes of the cray-fish can be distinguished is the manner in which the female carries the eggs; namely, in a mass upon the 'swimmerets' or legs of the abdomen. This test of the sexes can, however, be applied only when the females are spawning. These anatomical details are equally true of the lobster. Anyone who cannot readily obtain cray-fish can, perhaps, procure lobsters. These should always be bought alive and killed with chloroform as directed above (see chapter 1). It seems hardly necessary to state that boiled lobsters would be of little value for histological examination. The lobster does not present any advantages over the cray-fish for histological study, nor is it inferior to the cray-fish; choice between them should be determined by the superior readiness of obtaining either. It is not necessary to be particular with regard to sex in selecting material for the preceding studies, because the liver, green gland, and intestine are alike in both males and females, as are all parts of the body except the generative organs. Female specimen having been selected during the breeding season, it is first killed by immersion in water into which a small amount of chloroform has been previously dropped. After remaining in the water a few minutes (5 or 10), the body may be opened by cutting off the shell of the cephalothorax the large scoop-shape covering of the front part of the body. Removal of this displays the stomach in the middle in front, and the heart behind this; in front of the heart, and on either side of the stomach, the faint greenish yellow liver, composed plainly of tubes, and under the liver, on each side, the ovaries. These look brown in color, with no greenish tint like the liver, and are composed of minute globules, giving the organ an appearance like clusters of grapes. When found the ovaries should be gently drawn away from the surrounding organs and prepared for further examination, whether histological or anatomical. For anatomical study the specimen should, as soon as it is opened, be placed in strong alcohol (75–90 per cent.) and dissected at once. For sectioning, the regular course of hardening and imbedding should be pursued, or the egg may be studied fresh from the ovary. Numerous methods of hardening are available; perhaps the one most convenient is by the use of corrosive sublimate and acetic acid. The specimen from which the accompanying plate has been made and the present chapter written, was preserved, as described in chapter 1, for the green gland. It does well enough for our purpose. If the corrosive sublimate method were chosen, immerse the perfectly fresh ovary from a just-killed cray-fish (or lobster) in a mixture of saturated aqueous solution of corrosive sublimate to which about 1 per cent. of glacial acetic acid has been added. Leave the ovary in this solution about 15 minutes, then remove to running water for two hours. From the water change the specimen to 50 per cent. alcohol 1 hour, thence to 60 per cent. 1 hour, thence to 70 per cent. 24 hours (at least). After several diurnal changes of 70 per cent. alcohol, the specimen may be kept in that indefinitely until it is convenient to cut the sections. When such time comes, immerse in the stain, wash and alcoholize, then imbed with paraffine or celloidin in the usual way.

In imbedding eggs by the method requiring the use of heat especial care must be exercised. The bulk of substance of the egg of *Cambarus* is not the ordinary protoplasm of animal cells, but a substance often called deutoplasm, or nutritive food yolk. It is well known as the 'yolk' or 'yelk' of the egg of birds. This substance often causes considerable difficulty to sectioning because of its great hardness and brittleness in some cases. It both dulls the razor and often lifts the edge slightly, so that the even thickness of the section is interfered with. I have thought, without having especially attended to the point, that my sections were better if I kept eggs in melted paraffine of minimum temperature a minimum time. Some eggs of mol-

lusks have been unfit to cut because of the hardness. I have observed this caution in work on the cray-fish ovary and found no difficulty in securing entirely satisfactory sections.

II. Gross anatomy.—The ovary, as before stated, lies chiefly in the trunk or cephalothorax of the cray-fish. It is seen in the freshly opened body, where none of the parts have been displaced, behind the stomach, almost hidden by the liver on the sides and the heart behind. The part thus seen is but a very small portion of the entire organ, the remainder being concealed by the heart and liver. If the heart be carefully removed the ovary can be seen to extend backward beneath it, and removal of the muscles, which run from the front abdominal segment above to the sides of the bronchial chamber, will demonstrate the ovary extending back into the anterior abdominal segment. Careful dissection with fine scissors and needles will permit one to separate the ovary from the other organs about it, care being observed against mistaking the oviduct for one of the bands of connective tissue. As the ovary is gradually disengaged it may be turned back, the oviducts cut off, and the organ received for further examination in a watch-glass of normal salt solution.* Here its form and parts can be more carefully studied. It presents three portions, two in front, a right and left half of equal size and similar shape, and third single portion. The two front parts lie one on each side of the middle of the body, and the single portion lies in the middle line of the body. In the organ prepared without alcoholic hardening before a dissection the oviduct cannot be easily distinguished, but in the alcohol-hardened specimen a string of tissue will be found which passes from each of the two front portions of the ovary down through the muscles of the ventral side, and which finally run to the middle pair of legs. An examination of the under side of the body will show that the basal joint of this middle pair of legs is enlarged, and that a circular opening is placed on it looking backward. The opening is covered with a membrane which acts as a sort of lip to close the opening. The oviduct ends at this opening, and eggs which pass down the oviduct from the ovary escape through the opening to the outside, where they are caught up by the legs of the abdomen and fixed as 'spawn' till the time of 'hatching.' Naked eye examination of the ovary shows it to be made up of very numerous small globular eggs, and demonstrates over these a very fine film, which is recognized as covering the entire organ. A little teasing of the ovary received in salt solution shows that this substance makes up the ovary, and that the eggs are imbedded in it. It is in fact the ovary, properly speaking, and the eggs, which are the conspicuous part of the organ, are the products of its activity.

III. Histology.

1. *Examination of the section.*—The sections of the ovary, if no break has distorted them, will show a number of similar large bodies made up of many bright small droplets, some of them with a central body of large size, and each one bounded by a sharp line; and, besides these larger bodies, numerous smaller ones in the corners left among the larger ones. Figure 1 is designed to show, in a semi-diagrammatic manner, the facts which any good section illustrates. By name these different parts are (1) the egg, (2) the wall of the follicle, (3) the immature or young egg.

The egg.—Examination of the egg itself shows it to be a complex struct-

* Normal salt solution is made by taking common table salt 6 parts to 1000 parts distilled water. It is used for tissues to be examined fresh, instead of pure water, which is as fatal to fresh tissues as alcohol. It is better if slightly warmed. The reason for its use is because it imitates the chemical character of fluids in the body. Serum, or aqueous humor of the eye, or hydrocœle fluid, are still better.

Instead of dissecting out the fresh ovary one can dissect under alcohol 50 per cent., and then receive the organ in the same fluid. The latter process is easier, but it does not permit the examination of the contents of the ovary in a fresh condition, which ought to be done.

ure, and perhaps the novice might at first suppose it a body composed of numerous cells. We shall leave that point for the present to return to it later on, and study first the various parts seen in the egg. It is bounded by a sharp fine line which shows no structure, it is a thin membrane which entirely envelopes the egg after the manner of a cell wall investing the ordinary cell. It is known as the vitelline membrane, from the term vitellus, the name for yolk, and is the coat which encloses the yolk and the egg. The vitelline membrane does not in section form a complete circle as it would of necessity were the egg a perfect sphere, but is polygonal in outline. The eggs, as could be shown by studying a series of sections, are flattened against each other, thereby proving the flexible character of the vitelline membrane. Within the vitelline membrane may be seen a fine granular substance *g*, which stains readily and pervades the entire egg; this forms a sort of ground substance in which the larger granules are deposited. The finely-granular, deeply-staining matter of the egg is protoplasm. It has the same appearance to the eye, whether fresh or in sections, and stained or unstained, as the protoplasm in cells of the green gland or 'liver.' Scattered through the protoplasm everywhere, except in the centre of the eggs, may be seen small oval bodies *f* of various size. These are globular masses held in the protoplasm. In sections they stain or, better, tint evenly, but not deeply; they are homogeneous, often hyaline, but in some cases not quite hyaline, but more like very fine grains of ground glass. These grains are the usual constituent of the yolk of those eggs which have a yolk. They form the bulk of the egg of the cray-fish, and give it its yellowish brown color. The substance of which the grains are formed is believed to be albuminous because of its reactions, for it does not dissolve in turpentine nor turn blue with iodine. It is a substance made by the active protoplasm, and stored as food to be ready for use when the egg begins to develop. Since the egg is comparatively large, and the germinal vesicle *h* occupies only a small part of it, anyone can readily see that several sections passing through the middle of the egg on both sides will fail to intersect the vesicle. There will on that account be a number of eggs cut in each section which will show in their centre only protoplasm. In some, however, a central body may be seen, plain, unlike the protoplasm, and separated from it by a sharp, thin line. The central body is the germinal vesicle, is more open than the general protoplasm outside it, which gives it a lighter color, but the coloring matter may be seen to take a stronger hold upon the colorable substance in the vesicle than is the case in the egg at large. The outline of the vesicle wall is not perfectly circular, as shown in fig. 4, but this may be due to the action of the hardening reagent, for, as we shall see, the vesicle usually looks spherical in eggs examined in the living condition. Examination of the vesicle will show that near its periphery larger and more deeply-stained spots are seen forming a sort of zone of substance not unlike the general substance of the vesicle in composition, but greater in bulk. Without here reviewing the present known facts in the case, I may merely say that the biological writers are by no means agreed upon the structure of the vesicle, or the meaning of the light and dark, but they are agreed in finding here two substances, one of which stains and the other of which does not stain. The deeper tinted larger spots in the peripheral zone are the bodies known as nucleoli, which are only larger masses of the stainable substance.

After this review of the parts found in the egg, it would be expected that I should next try to discover the part played by each, if that be possible; this question I will adjourn till the close of the present chapter. I wish, however, to delay at this point long enough to suggest the answer to the question asked a moment since, viz:—What is the cellular status, so to speak, of the

egg? The facts in the case are that the egg, as we see it in our section, consists of protoplasm, a central vesicle with many resemblances to a cell nucleus, and an outer membrane like a cell wall. These data alone would be enough to lead us to pronounce the egg a cell, were it not for its extraordinary size, and for the presence of so much 'foreign matter,' the yolk.

The follicle wall.—Beyond the egg, following it closely, and without a break at any point (except such breaks as are due to the imperfection of the observer's manipulation), is a thin line. This line, in the section, is built up, by interpreting many serial sections, into a wall which envelopes the entire egg. In fact, the egg is entirely enclosed by a capsule called its follicle. Sections which pass through the end of the egg often give fine oblique or flat surface views of the follicle, and very readily and indisputably establish its histological character. Such a section is shown in fig. 3. Examination of the follicle wall (in very good sections only) at a point between the eggs, as at *d*, fig. 1, will show two rows of flat cells. If from this point the section be traced along, the wall can be followed double for some distance, but finally diverging into two parts which run off each one to enclose its particular egg. The wall is thus proved to enclose the egg completely, and to be entirely distinct, histologically, from that of adjoining eggs. The follicle furnishes beautiful pictures of the pavement epithelium. In the cross sections of the cells, at the middle of the eggs, the nucleus can be seen thicker than the cell elsewhere, while between the cells the boundary cannot be seen at all. In the surface views (fig. 3) the polygonal cells, with their outlines faintly traced, show very well the character of the follicle.

The immature egg.—In the corners left between the large eggs may be seen small bodies, shown in fig. 5, which are the predecessors of large eggs, the young of a later generation. These bodies have the same situation as the large ones, being completely enveloped by a cellular capsule, their follicle similar in character to the capsule of the mature egg. The immature egg presents a number of points of unlikeness to the mature egg, and it is hardly likely that the observer would connect the two as different only in age, were it not for its relation to the egg follicle. The immature egg is invested with a membrane with all the characters of an ordinary cell wall. The size is not much greater in the case of some ovules than that of the follicle cells. The ovule contains throughout, besides its germinal vesicle, pure protoplasm like other cells, with no trace of the yolk so prominent in mature eggs. The centre of the ovule is occupied by a relatively large nucleus or vesicle in which much the same appearance is seen as in mature ova, differences being, perhaps, more individual than due to characteristics of different ages. So far as any difference seems general, it is in that the nuclei are not so distinctly in a peripheral zone, but scattered through the egg they should be shown by darker spots in figure 5. It must be stated here to prevent the chance of mistake that the mature egg, as here described, is the egg before union with spermatic fluid of the male has taken place. The mature egg is the egg ready for that union; we have nothing to do here with the changes in the egg during fertilization and later, but only the description of the ovarian egg.

[*To be continued.*]

The Cosmopolitan Magazine has of late made very decided advance, and the May number is, in our opinion, the best one thus far issued. It has taken a place among the best magazines. The use of colors in the illustrations, at first hardly an addition, is in the colored illustration of Moncure D. Conway's admirable article on 'The Pedigree of the Devil' a very decided success. We must congratulate the new management upon this very great improvement. The tone of the entire magazine is elevated, though the articles are popular and likely to interest a wide class of readers.

REPORTS OF RECENT ARTICLES.

On the possibly dual origin of the Mammalia.—Prof. St. George Mivart,* remarking on the recent discovery, by Mr. Edward Poulton, of non-functional teeth in the jaws of young ornithorynchus, says that, taken in connection with Caldwell's discovery of oviporous reproduction, it greatly strengthens the evidence previously relied on by certain naturalists, that the ornithodelphia descended from some reptilian form. These teeth found by Mr. Poulton, however, are distinctly mammalian and have no parallel among the reptiles, and yet are not closely like the teeth of any other mammal. He then seeks the ancestry of the monotremes, and in view of Gegenbaur's discoveries, that their mammary glands are wholly unlike in origin to those of marsupials and placentals, mammals being modified sweat glands, while in the other mammals they are sebaceous follicles, he urges for them an origin 'from a radically distinct stock from that from whence all other mammals proceeded.' 'The monotremes are an example of hypothetical higher animals in the making, the future evolution of which may probably be hindered by man's presence, but which, did they appear, would produce mammalian forms more or less parallel to, but, of course, radically different from the placental and marsupial series of mammals.'† He assigns to them a comparatively recent origin from the reptilian line much posterior to the date of inception of the 'superior mammalia.'

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Pineal Eye in Lacertilia.—W. B. Spencer‡ concludes that:—1. Our present knowledge is not great enough to allow us in Amphiurus to homologize any structure, either with the tunicate azygos eye or with the epiphysis. 2. The epiphysis of higher chordata is the homologue of the tunicate eye. 3. The pineal eye is produced as a secondary differentiation of the distal part of the epiphysis. 4. There is not sufficient evidence to prove or disprove the existence of the organ within the group pisces; it was present in extinct amphibia and is found amongst living forms only in lacertilia. 5. In all forms at present existing it is in a rudimentary state, and, though its structure is better developed in some than in others, it is perfectly functional in none. 6. It was present and most highly developed in, (1) extinct amphibia; (2) Ichthyosaurs, Plesiosaurs and Iguanodon, etc., ancestors of present reptiles. 7. Pineal eye may be most rightly considered as peculiarly a sense organ of pretertiary periods.

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Phosphorescence, Organ of.—J. T. Cunningham and Rupert Valentin § find that in *Nyctiphanes*, a crustacean allied to the shrimp-like *Mysis*, organs formerly described as accessory eyes, and situated as follows:—one pair behind the eyes, two other pairs on the trunk, and four more on the median line of the tail, are organs giving rise to the phosphorescence produced by the shrimp, and investigate the organs thoroughly for the first time. Each organ is a low mound on the surface with a transparent 'cornea,' and beneath it a 'lens.' The organ is globular, and its curved hind-side is composed of a concave 'reflector' or pad of connective tissue; between the reflector and the lens the space is filled with columnar cells. Experiments with the creature seem to prove that the power of emitting phosphorescence is under control of the nervous system because bright flashes can be caused in response to

* Proc. Roy. Soc., vol. xliii, p. 372, 1888.
† This view of the relation of the monotremes as at once mammals and not mammals is peculiar and unsatisfactory. We have only room to mention it here without discussion.
‡ Quart. Journ. Mic. Sci., 1887, p. 232.
§ Quart. Journ. Mic. Sci., 1888, p. 320.

stimulation, and these gradually become dim and disappear with its cessation. The precise manner in which the nervous system causes the light-formation is uncertain. Experiments seemed to show the reflector to be the seat of the action, but this was not positively proven.

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Marine biology and the electric light.*—The steamer *Hyæna* was used by the Liverpool Marine Biology Committee in April for a three-days' exploration between Liverpool and the Isle of Man. Besides determining soundings and fauna of the bottom in the area studied, experiments with the electric light were made, which were the most worthy of notice of all events of the cruise. On the first night in Ramsey Bay, Captain Young, who was in command of the *Hyæna*, arranged a 60-candle power Edison-Swan submarine incandescent lamp in the mouth of a tow-net. The illuminated net was carefully let down to a depth of 3 fathoms and allowed to remain there for half an hour. At the same time, another tow-net without any light was let down to the same depth over the opposite side of the ship. When the two nets were hauled in the former had collected an abundant gathering, the latter practically nothing.

A repetition of the two experiments at a depth of 6 fathoms confirmed the first experiment. On the following night, at another station, both nets were illuminated, and one sunk to the bottom at 5 fathoms and the other used at the surface. This was repeated three times, and each net was found well filled, but the surface collection was found to differ widely from the bottom gathering. The latter contained mainly large Amphipoda and Cumacea, while of the surface forms Copepoda were most abundant.

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The rabbit pest in New Zealand.—The United States consul at Auckland, in a recent report, describes the extent to which New Zealand has been economically injured by rabbits, and the cost incurred in endeavoring to exterminate them. Nothing, he says, could so overrun a country since the locusts of Egypt. The rabbits have so eaten out the ranges that the capacity for maintaining sheep has greatly lessened, and the flocks have fallen off in numbers. At the Stock Conference of 1886 it was stated that rabbits reduced by a third the feeding capacity of land, and that the weight of fleeces had decreased by 1 lb. to 1½ lbs. each. The number of lambs decreased from 30 to 40 per cent., while the death-rate increased from 3 to 13 per cent. Since 1882, when the Rabbit Act became law, government has expended £7,000 on crown lands alone, and it is estimated that, during the last eight years, private persons have spent £2,400,000 in extirpating rabbits. The methods generally in favor were fencing, poisoned grain (generally phosphorized oats), and ferrets, weasels, and stoats. Large numbers of men have been hired from time to time to make war upon the rabbits, and it is said that these 'rabbiters' encourage the vermin in every way, and had been caught killing the stoats and ferrets. The bonus system has been found objectionable and expensive. Notwithstanding all that has been done, in some localities, the rabbits have continually increased and the damage has continued. It is hoped, however, that, as the country becomes more populous, and the large tracts of land are occupied and cultivated, the numerous herds of rabbits which now roam over the land will disappear.—*Eng. Mech.*

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Amphileptus encysted on Vorticella.—Eighteen years ago I was paying much attention to Vorticella. I was observing, with some pertinacity,

* From Nature, June 7, 1888.

Vorticella convallaria, for one of the calices was in a strange and semi-encysted stage, while the remainder were in full normal activity. I watched with great interest and care, and have in my folio still the drawings made at the time. The stalk carrying this individual calyx fell upon the branch of vegetable matter to which the Vorticellan was attached, and the calyx became perfectly globular, and at length there emerged from it a small form, with which, in this condition, I was then quite unfamiliar. It was small, tortoise-like in form, and crept over the branch on sitæ or hair-like pedicles; but, carefully followed, I found it soon swam, and at length got the long, neck-like appendage of *Amphileptus anser!*

Here, then, was the cup or calyx of a definite Vorticellan form changing into (?) an absolutely different infusorian, viz., *Amphileptus anser!*

Now, I simply reported the fact to the Liverpool Microscopical Society, with no attempt at inference; but, two years after, I was able to explain the mystery. For, finding in the same pond both *V. convallaria* and *A. anser*, I carefully watched their movements, and saw the *Amphileptus* seize and struggle with a calyx of *convallaria* and absolutely become encysted upon it, with the results that I had reported two years before. And there can be no doubt but this is the key to the cases that come to us again and again, of minute forms suddenly changing into forms wholly unlike.—*Prof. Dallinger, in Presidential Address to Royal Microscopical Society, 1888.*

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The Microscope in the Diagnosis of some Cases of Hay Fever.—In the *Journal of the New York Microscopical Society* for April Prof. Samuel Lockwood treats of the 'Pathology of pollen in Aestivis, or Hay Fever,' and describes a form of pollen which fills the air at certain times in the White Mountains, and causes great suffering among the guests at the various hotels and sanitaria who are subject to hay fever. The microscope shows the pollen to be that of the 'golden-rod' and of the 'rag-weed.' The experience of Prof. Lockwood reminds me of an incident which occurred in my own practice several years ago. A lady owned a beautiful plantation on the Mississippi river about 90 miles above Memphis, Tenn. She could remain at home the year round in health and comfort except at a certain time in the very early spring, along in February, if I remember correctly. Then she would commence to sneeze, and, after a day or two of occasional spells of sneezing and running at the nose, febrile symptoms would come on. These were attended with swelling of the lids, inflammation, and finally a complete closing of both eyes. Asthma and all the other delights of hay fever were also present, and, unless she left home, this condition of things would last not less than two and sometimes as long as six weeks. If she went away from home even for a few miles, especially if she left the 'bottoms,' she would recover like magic. I was called to attend her one spring, and being satisfied from the history of the case that the inciting cause was local and mechanical, I examined the discharge from the nostrils and found it full of a peculiar pollen. The trees were all bare as yet, and there was no sign of a green twig or leaf to be seen. A systematic search of the trees about the house, around the lawns, and in the park (a 2000 acre tract of wooded land) finally showed me that the pollen was that of a species of alder, which grew in great plenty there but nowhere else in the country. According to orders from the mistress, all the trees of that species that could be found were sacrificed, and after that the attacks were much milder, though she did not quite escape. This was owing no doubt to residual trees growing on lands not belonging to her.—*St. Louis Med. and Surg. Jnl.*

Cells and Protoplasm.

By H. W. CONN,

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Modern microscopic methods have revolutionized our knowledge of protoplasm and of the organic cell. Since the time when Beale wrote his ideas on the cell, or when Huxley published his conception of protoplasm in his 'Physical basis of life,' so much has been added to our knowledge that entirely new positions must be taken, even by those who are inclined to accept either of the two extremes.

Formerly protoplasm was thought to be a very definite though a very complex compound. The term physical basis of life was given to it under the conception, that it was such a definite compound, always found where life existed, and practically uniform. Indeed, to speak of a physical basis implies that such a basis must be a definite substance and not a highly complicated and variable one. But the modern microscope, modern methods of staining, and modern careful study have changed all this. In the first place the seeming homogeneity of protoplasm has been disproved. Instead of a simple homogeneous jelly, the microscope now resolves it into a very complicated structure. It may always be resolved into two parts, one which is the life-substance, called the protoplasm proper; and the other, the food substance, called the deuterplasm. The deuterplasm itself is a purely secondary substance, containing cell-sap, oil drops, food sphereis, etc. It is to the abundance of this deuterplasm chiefly that the size of large cells is due.

The protoplasm proper is itself very complicated. It has one universal characteristic; it is always reticulated. Sometimes the reticulum is quite coarse and sometimes it is very fine. Its meshes are filled with the deuterplasm which supplies the protoplasm with its nutriment. The reticulum itself is made of threads of a hyaline material, and in these threads or fibres are embedded numerous extremely minute bodies which have been called microsomata. Both the protoplasm and the microsomata are essential to the protoplasm as is proved by their constant presence and by the peculiar changes that they undergo during cell division. It is the changes in this fibrous network and in the microsomata that constitute the phenomena known as karyokinesis. Now it is hardly to be supposed that the simplest substance to which life can be reduced should be of such a complex nature. It seems much the more probable that one of these substances should be the primitive one and by its action produce the other. If this is true there is little doubt that the microsomata should be regarded as the primitive elements and the reticulum as secondary. Where there are these microsomata there is life. These minute bodies are grouped together, differentiated in one way and another, and by their different groupings give rise to the various forms and properties of protoplasm.

Chemically, too, our former dense ignorance of protoplasm is beginning to disappear. Until recently about all that was known of it was that it was composed of the elements, carbon, oxygen, hydrogen, and nitrogen, with other elements in small proportions. This was supposed to be united into a very complex molecule which was beyond the power of chemists to analyze. As long as only ordinary analytical methods were used it was impossible to discover more. But recently microscopical chemistry has been developed, and has already done something in the study of protoplasm with great promise of much more in the future. No longer can we regard protoplasm as a single chemical compound, but we must look upon it as a mixture of compounds. First, there were distinguished chromatin (nuclein) and achromatin; so named from their ability to absorb staining reagents. The former is present chiefly in the

nucleus and the latter in the rest of the cell. But this is only a beginning; for these bodies have been still further resolved, and one investigator in this line finds not less than five different chemical compounds in the nucleus alone, and still others in the cytoplasm outside of the nucleus. Chemical differences, too, between the protoplasm when living and when dead have been detected; the former having the power to decompose certain of the nobler metals from their solutions, while the latter has not this power. Numerous points of likeness have been traced between the activities of protoplasm and ordinary chemical processes. Urea, formic acid, oxalic acid, salacilic acid, alcohols, ethers, glycerine, wintergreen, vanilla, cinnamon, camphor, etc., all substances formerly thought to be possible of production by the means of protoplasm alone, have now been manufactured by purely synthetic processes in the chemist's laboratory. Oxidizing and reducing processes are constantly going on, and to these many of the activities of protoplasm may be referred. It is stated that when lifeless protoplasm becomes living, heat is rendered latent. Motion of protoplasm is said to be due to the stretching and contracting of the protoplasmic fibres caused by changes in its density, the result of oxidizing and reducing changes. Much of this is, of course, crude hypothesis, and, as yet, largely guess-work; particularly is this true as to the relation of the activities of protoplasm and chemical changes. The subject is, as yet, only in its infancy, but we are certainly beginning to know something about the chemistry of protoplasm. We know that it is not a definite chemical compound, and that protoplasm itself can no longer be called the physical basis of life. If we are to speak of a physical basis it must be of the microsomata; and really we have no reason to think that these are the ultimate life elements.

Naturally the content of our conception of the organic cell has been greatly changed by this study. It was formerly called the unit of organic life. It is now known to be a complex colony of such units, if indeed such units can any longer be said to exist. At first the cell was regarded as a cell in the true meaning of the word, and the cell wall was looked upon as an essential part of it. The cell wall was soon found to be only a secretion from the protoplasm, and this was, therefore, then regarded as the essential part. But this left the nucleus without any meaning. The importance of the nucleus slowly grew in the minds of cytologists. It was found to be almost universally present in cells, and, to-day, cytologists think that it is really always present, though sometimes in a diffused state, which renders it not readily visible. It was found that the nucleus always began cell division and had an important part to play in fertilization and reproduction in general. When the more minute anatomy of the cell was further studied the importance of the nucleus was still more apparent. It is in the nucleus that all initiative processes of cell life begin. When the union of sexual elements takes place it is really the nuclei that unite. For the spermatozoan is really a part of the mother cell in the testis, and this unites with the germinal vesicle of the egg which is *its* nucleus. Of course it follows from this that the nucleus is the sole organ for the transmission of inherited characteristics, and it must contain the essential life essence, whatever that may be. It is found that life may go on in a fashion without a nucleus being present in the protoplasm. Experimenters have artificially divided the cells of large protozoa and found that each piece would continue its life processes; but only those containing a bit of the original nucleus were able to reproduce themselves by fission or otherwise. Thus it is shown that without the material which is present in the nucleus there is no possibility of perpetuation of species. In accordance with its important functions, the nucleus is found to be correspondingly complicated, not only in its chemical nature, but also in its structure. The protoplasmic reticulum is here the most dense, the microsomata are the most abundant.

Usually the microsomata are grouped together into one or more masses which appear as little rounded bodies. These are what have long been known under the name of nucleoli. Of course if the microsomata are the fundamental life elements the nucleoli must be regarded as special centres of activity. And this is not the end. It frequently happens that inside of the nucleolus there is a still smaller body, and sometimes inside of this still another. Each of these masses of microsomata may be looked upon as successively nearer the real centre of activity of the cell. Cytologists are indeed now inclined to think that a single one of these minute microsomata is enough to be the starting-point of a cell; and if this is true the complexity of a single cell or a single nucleus or even a single nucleolus, is almost inconceivably great. Perhaps the best evidence of this is shown by the phenomena of karyokinesis. Every student of biology knows of the great changes taking place in a cell during cell division. These complicated karyokinetic figures are formed in the nucleus by the movements of the microsomata and the protoplasmic filaments. No two cells are known to go through exactly the same phases during cell division, which is sure enough proof that the nucleus is not a simple body, but one of extreme complexity.

In short, the study of the last few years has developed a new branch of science. The study of cytology is fast coming to have its special students, its special literature, and its special terminology. Cytology includes not only the study of the external appearance of cells, but even more the study of their internal structure, and the structure of protoplasm. Some day it is not improbable that it may include a study of the history in the early processes in the formation of cells from the simpler elements of life, just as embryology includes the study of the history of the development of animals.

Wesleyan University, Middleton, Ct., *July* 14, 1888.

Three cruises of U. S. S. Blake in the Gulf of Mexico, Caribbean Sea, and along the Atlantic Coast of the United States.*

By Prof. ALEXANDER AGASSIZ.

These two volumes form volumes xiv and xv of the Bulletins of the Museum of Comparative Zoology, at Cambridge, Mass. While scientific in character, they are not exhaustive monographs, but a narrative of the cruises, and they attempt to picture for the reader the topography and inhabitants of the sea, both its surface and its depths, a 'contribution to North American Thallasography.'

Passing over 38 pages devoted to the interesting account of the apparatus, we find chapter iii (41 pages) devoted to the Florida reefs, separated from the islands or keys by a channel of from 3–15 miles in width, navigable for small vessels. The coral island theories are reviewed in connection with these reefs, and Darwin's theory, explaining the growth of atolls as solely due to the subsidence of volcanic peaks, is objected to. 'We must look to many other causes than those of elevation and subsidence for a satisfactory explanation of coral-reef formation. All important among these causes are the prevailing winds and currents, the latter charged with sediment which helps to build extensive plateau from lower depths to levels at which corals can prosper.'

The chapter on pelagic fauna and flora is full of interest for the biological student. Including representatives of nearly all littoral forms, they are usually smaller, translucent, and often of most exquisite color, tinting the surface for miles, so numerous are they, and at night so brilliantly phosphores-

*2 vols., pp. 314; pp. 220. Boston. Houghton, Mifflin & Co., 1888.

cent. 'On tempestuous nights the phosphorescence, intensified by the motion of the vessel, adds singularly to the wildness of the scene. Each wave rises like a mass of molten iron and seems to threaten the vessel with destruction; it breaks, then passes off in her trail, and adds new beauty to her brilliant wake.' Among these are many creatures unknown to the zoologist of fresh-water or the northern shores, forms of curious shape or beautiful color. *Physalia* and the 'Portuguese man-of-war' and *Porpita* floating medusæ, *Argonauta*, *Atlanta*, and *Janthina* mollusks which never seek the shore, and see it only when borne there to their own destruction by the gale; the innumerable microscopic forms of animal and plant life, among them *Globigerina* and the other protozoa, and all the host of minute creatures, both larval and adult. We must mention, for their beauty, also, the iridescent ctenophores, perhaps the most beautiful of all marine surface forms, for the wonderful play of colors along the rows of locomotive paddles.

On the physiology of deep-sea life, the following facts are established:— Man inhabits the depths of the air while deep-sea animals inhabit the deep sea, but the conditions are very unlike; on land we have extreme variation of temperature (—78° F. + 120° F.), while in the sea depths the temperature is practically uniform, while on the other hand, pressure range is slight on land and very variable at different levels in the water. Animals at the sea-bottom are subject to enormous pressure; at 1,000 fathoms it is estimated to be one ton per square inch. But marine animals whose bodies are permeated by fluids readily adapt themselves to these immense pressures. Fishes and mollusks suffer most from sudden removal from them. The latter come up in a dredge with swim-bladder protruding from the mouth, eyes forced out of their sockets, and scales fallen off the body. It is thought that light penetrates only to a depth of 200 fathoms, but faint rays of certain colors may reach greater depths. Since many deep-sea animals are phosphorescent, some have thought they were able to slightly illuminate the dark depths. It is true that many of the deep-sea bottom animals, from great depth, have eyes which are constructed like those of their allies on land or at the surface; usually, however, their eyes are larger, as if to collect more light. Some deep-sea forms are blind; so, also, are others dredged from a depth of less than 200 fathoms. They are very likely creatures which live in the mud, and do not wander about at large. These blind ones, many of them, give evidence of a much more delicate tactile sense to compensate the visual deficiency. While whites, reds, oranges, greens, and greys are found among the colors of marine animals, blues are never met except in a few pelagic forms; this is the more odd because of the protection it might be from resemblance to the color of the sea. The distribution of marine plants plays an important part in the food supply of shore animals; carnivorous animals living upon animal feeders. It is therefore curious to notice that vegetable life is entirely wanting from the population of the deep sea, hence the source of food of the deep-sea forms becomes an interesting problem. It is found that the dead carcasses of even very light animals will sink to the bottom of the sea still fresh enough to supply a large amount of food for bottom carnivores, and the fauna of the surface thus becomes a medium for the transfer of food manufactured by surface vegetation; also to the foraminifera and sponges of the bottom a sort of 'broth,' formed of partly decomposed matters from the surface and along the shores, is distributed by the ocean currents, and this probably remains serviceable for a long time, putrefaction being very slow.

The entire second volume is taken up with the description of characteristic animals of the deep sea and the wonderful illustrations of some of the creatures described, many of which are remarkably unlike the surface and shore

forms. One fish, *Gastrostomus*, discovered has no paired fins and lives imbedded in mud up to its neck. The distance from the tip of its nose to the articulation of the jaw is a third larger than from the joint to the beginning of the tail, the body proper, and opens like a huge funnel, while the eyes are reduced to a pair of minute spots at the extreme point of the upper jaw. Many of the hermit crabs, hard pressed for protection for their delicate abdomens, are strangely modified. One *Xylopagurus* bores a hole in a piece of wood or finds a hollow plant stem open at both ends and closes the opening by his tail and stout anterior claws. The hermit, unlike most familiar ones, is straight and not spirally coiled. Space does not permit an enumeration of the odd and grotesque forms which people the ocean's bottom, but anyone who can do so would find a visit to this museum of wonders full of interest, perhaps novelty. The account is mainly a review of the peculiarities of shape and color with not much which is of a speculative nature. The problems of the relationships between these divergent deep-sea animals and their relatives whom we know better, and the search for the particular causes which have made particular forms what they are, are not entered upon in these volumes, which attempt rather a picture of the facts than monographic completeness.

Variations in microscopic measurements.

By CHAS. FASOLDT, Sr.,

ALBANY, N. Y.

Having found that the measurements of the committee of the American Society of Microscopists and mine did not agree, I have attempted to discover what the cause of the variation might be, and this is the result:—

During the last six months I have worked considerably on investigations into this matter, and to convince myself that the difference was caused by the various applications of illuminations, etc., as given in the table below.

The image of $\frac{4}{10}$-inch was the object on which these measurements were made, and was ruled on a glass disc of No. 2 covering glass $\frac{7}{1000}$-inch in thickness. All measurements were taken on the same ruling, with the same microscope, objective, and eye-piece, under the same focus, and having the microscope in the same position continually, and only changing the mirror and excluding the one light while the other was used. A number of comparisons were made at each position and in the same temperature.

A Spencer objective was used for these measurements, but Bausch & Lomb and Gundlach objectives were also tried, giving the same results.

The microscope used is one constructed on my late patents and has a micrometer for measuring similar to a cobweb micrometer. But instead of cobwebs, three movable steel pointers are used, which are worked as fine as this metal will permit. The stage is mechanical, and the main slide is moved with great precision by a fine screw 100 threads per inch.

Table showing the variations in measurements due to the different applications of light and illumination.

UNMOUNTED.

Lines downward.		*Lamp light.*	*Lines upward.*		*Lamp light.*
Concave Mirror, - -	$\frac{4}{10}$ in.	$\frac{10}{100000}$ —	Concave Mirror, - -	$\frac{4}{10}$ in.	$\frac{10}{100000}$ +
Plane Mirror, - -	$\frac{4}{10}$ in.	$\frac{5}{100000}$ +	Plane Mirror, - -	$\frac{4}{10}$ in.	$\frac{14}{100000}$ +
Ill. through objective, -	$\frac{4}{10}$ in.	$\frac{5}{100000}$ +	Ill. through objective, -	$\frac{4}{10}$ in.	$\frac{15}{100000}$ +

MOUNTED ON GLASS.

Lamp light.			*Day light.*		
Concave Mirror, - -	$\frac{4}{10}$ in.	0	Concave Mirror, - -	$\frac{4}{10}$ in.	$\frac{30}{100000}$ +
Plane Mirror, - -	$\frac{4}{10}$ in.	$\frac{15}{100000}$ +	Plane Mirror, - -	$\frac{4}{10}$ in.	$\frac{20}{100000}$ +
Ill. through objective, -	$\frac{4}{10}$ in.	$\frac{31}{100000}$ +			

July 3, 1888.

MICROSCOPICAL METHODS.

Investigating nerve tissues.*—In studies upon the histology of nerve tissues Mr. F. Nansen used both fresh macerated tissues for teasing and hardened slices for sections. Some fresh tissues were teased in the blood of the animal as a medium and examined. Others were macerated in Hatter's fluid, made of 5 parts acetic acid, 5 parts glycerine, and 20 parts distilled water; immersed 1–24 hours; teased in 50 per cent. glycerine stained picro-carmine. For sections he used Flemming's mixture, made thus:—1% chromic acid, 15 parts; 2% osmic acid, 4 parts; acetic acid, 1 part. Small pieces of tissue must be treated in a large quantity of the fluid for 12–24 hours or longer. After washing they should be included (not imbedded) in paraffine and cut under alcohol or water. A slight departure from Golge's method was used, as follows, upon *Myxine glutinosa*:—The nerve cords divided into pieces one or two centimetres long were laid in potassium bichromate (2%) for an hour, then the solution changed and made a little stronger and left 24 hours; from this to solution of 4 parts 3% potassium bichromate and 1 part 1% osmic, and left 3 days; from this to wash of .5% silver nitrate, and then in 1% solution one day. Sections need not be very thin; if the staining is good the ganglion cells will be seen with all their processes, and 'nerve-tubes' with their ramifications will appear quite dark or black on a transparent field. Specimens should be mounted in balsam, uncovered, the cover preventing the evaporation of the balsam solvent. Mounts must, when not in use, be kept in a dark place.

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New staining fluid.†—Mr. J. W. Roosevelt recommends an iron stain, consisting of 20 drops of a saturated solution of iron sulphate, 30 grammes water, and 15–20 drops pyro-gallic acid. The preparation assumes a brownish-grey color. It is specially suitable for photo-micrographic purposes, because, when united with albuminous tissues, it undergoes no further change.

Bismarck brown may be used for staining sections on slide, after being held by collodion varnish, if the solution be made as follows:—Saturate 1 part of absolute alcohol with Bismarck brown and add 2 parts of distilled water.

EDITORIAL.

The scope of this Journal.—While attempting no considerable departure from the course formerly pursued in this *Journal's* literary management, we, perhaps, have tried to make it less and less exclusively a strictly technical magazine by admitting to its pages a considerable amount of matter of popular interest in biology. Being thoroughly of the opinion that there is a growing interest in our colleges and lower schools, and also among the business people of this country, in the young science of biology, it has been in part our purpose to present a record of some of the new things from the world of biological science. In doing this we recognize two sources of material for our pages; first, the contributions of those who are meeting biological problems with their own microscope, and those who assist us by furnishing reports of progress from the great active field of study. Questions from subscribers show us from time to time how large an element the beginners are among the readers. We well recall our own helplessness when at the age of fourteen years we received at Christmas time a good microscope,

* Journ. Roy. Micr. Soc., 1888, p. 312.
† Journ. Roy. Micr. Soc., 1888, p. 157.

a dozen slides, and a book on mounting microscopic objects. How we put a hair without any preparation under the lenses and were awe-stricken at the apparent size of it, and missed entirely the wonders to be seen if the hair had been properly treated with reagents. Then we made futile attempts at macerations and finally ceased in disgust till help came.

It is the purpose of the editor to meet the wants of a various group of readers. Some beginners, and not scientific students, want to know how and what to see and have a clue given them to the deeper facts which they know are beneath the mere surface they see. Other general readers in science desire to know what new and important facts science is finding out, while still others are old users of the instrument, professionally or for amusement, and they look to the *Journal* for the latest new '*kinks*' of method, or for suggestions as to new lines of study or research. To furnish each such reader with some matter which he will find to meet his wants has been our aim from the beginning of our relations with the *Journal*.

We are anxious for one word here of a personal character to our readers. It is respecting questions and contributions. Some who write for information regarding methods of work have hesitation about using the editor's time for such purpose. We desire to repeat what we have said before, that we are never too busy to answer an honest question from anyone, and more, are most glad to do so, because we thereby learn of the needs of our readers. No one need ever hesitate to ask questions on biological topics. These we will promise always to try to answer or to refer to a source of information. We also wish to say that all matters which interest any observer are likely to interest others, and are fit subjects to contribute. We earnestly desire to attract to our pages for the sake of beginners contributions from beginners. The *Journal* is largely dependent for its success upon the knowledge of what its friends wish us to do for them.

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American Society of Microscopists.—The date of meeting has been changed by the executive committee to August 21st on account of the change of the meeting of the A. A. A. S. to August 15th.

We trust that suggestions which have been uttered during the year by the various microscopical journals will not be without issue so far as the meeting of the American Society of Microscopists can take action in the matter. We should be glad to see, and we think it entirely possible and advantageous, the American Society of Microscopists become the head and directing force of a large number of the microscopical chapters formed of the local societies of various cities, which might be elected to membership upon their wish and agreement to maintain a certain standard of work. We would have a committee appointed to look into the matter of forming a general society for the purpose of helping the weaker societies into a genuine hearty life. It seems to us that the cause of science could have no better gift from the American Society of Microscopists than the increased recognition of the value and importance of scientific work which must necessarily be the outcome of a diffusion of knowledge of scientific methods of study. While we regard the amateur use of the microscope as a very valuable and interesting source of amusement, and entirely to be urged on that ground, we conceive that an even greater benefit results to the good cause of progress from an increased appreciation of the nature and value of biological study. The material progress of the last century has been demonstrably due to free intellectual or scientific activity. We need not argue that old point. By popularizing science we are making the way for the continuance of the progress we of 1888 are favored to enjoy. The greatest benefit of such meetings as the

summer meetings of the great societies is the spread of knowledge into new channels which they effect. Shall this be a matter of a few days in August, or cannot some means be devised whereby the good can be made perennial? It has seemed to us that the local societies, which are some of them semi-dormant, can be stimulated by an efficient organization into useful activity.

Should any plans for organization be put into operation the movers of them may count upon the hearty co-operation of this *Journal*, both in urging the importance of the matter of the societies falling in with it and in helping the chapters in any way with plans for work. We trust it may be a subject of serious consideration in the August meeting.

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Human interference in the economy of nature brings about some astonishing results which may well caution man to learn as well as possible the conditions which regulate the existing order of things before he attempts to modify it for his own good. To one who thoughtfully looks at the facts of science a wonderful balance is apparent, and he finds an extremely intricate set of inter-relations determining the natural conditions as he finds them. In New Zealand the introduction of the European rabbit has so far disturbed the natural balance of the native fauna that it has overrun everything. This we see to be due to his removal from the antagonism of the various competitors—foxes, for instance—which in his native land contended with him for a livelihood. Man, who disturbs the balance of nature, does not sufficiently know the conditions to provide all the checks which would prevent the excess he cannot foresee. We have another instance of the same fact, in the introduction into our own country of the English sparrow, which has done more than all the hat trimmers, ruthless as they are, to exterminate our native song birds. This law is to be noted as general; we cannot be too careful when we attempt to modify nature for our own good. The cutting down of forests too extensively will, it is urged, make desert many places now fertile. The extermination of many wild native animals before man's entering into possession of our West is certain in some instances and accomplished in others. One entomologist of our acquaintance proposed, for the extermination of an introduced pestiferous insect which had gotten established in this country away from his natural enemies and throve proportionately, to introduce the enemies, whereby, he thought, the pest could be kept in bounds. This, we believe, was successfully attempted. What a comfort, if an enemy of the mosquito, harmless to man, could be found who would thin the ranks of that pest. Many of man's interferences are resulting favorably, and others proposed commend themselves at once. Thus the artificial propagation of fish for food and the legislation to prevent the extermination of the oyster. A survey of the facts would show that the improvement in our knowledge of the conditions of existence of animals and plants of economic importance is the key to the great problem, how shall we prevent the means of living from becoming too scarce as the increased population makes heavier and heavier demands upon it. It is certain that we cannot expect to successfully answer this question if we permit men to take their own course, and also certain that the only answer to be found is in an increasingly perfect knowledge of the laws of the interaction of extensive natural phenomena which man must learn to guide. Prof. Huxley in a recent review of the future of the poor finds the solution of the question in their education. The only true and lasting improvement is to be sought here, and not in any chance discovery of new mines, coal-beds, or fishing grounds, and forms of new food fish, much as they may lend to a temporary help, they are in their nature exhaustible, and we must learn nature so as to make her production exceed man's drain upon her stores.

QUERIES.

The following questions are from a subscriber in Brockton, Mass., and are answered by a friend in Battle Creek, Mich.:—

First:—What is the American Postal Microscopical Club? This is an organization composed of ladies and gentlemen, professional and non-professional, interested in the use of the microscope, and scattered, for the most part, throughout the eastern half of the United States, with headquarters at Troy, N. Y. Boxes containing slides are started out from headquarters, sent to various circuits (consisting usually of six members), passing from individual to individual, and by the last one in each circuit forwarded to the first one of the next circuit, or returned to headquarters, according to instructions contained in the 'mailing slip,' which is attached to the note book of each box. Each member of the club is entitled to three days' use of each box of slides. These boxes (excepting Cole's Studies) generally contain six slides, contributed by members of the club, each donating one or more per year, which shall be of interest to the larger portion of the club, ordinary slides not being desirable. Cole's Studies consist of only two slides in each box, with an illustrated descriptive pamphlet. Accompanying each box is a 'Note Book,' in which each slide is more or less fully described, giving the common and scientific names of the object, method of preparation, manner of mounting, and often containing notes by the contributor, or by others through whose hands the box has passed, upon the special points of interest in the slides. Many of these notes or memoranda are very interesting and instructive. In some cases pencil, ink or water-color sketches have been embodied in these notes, and in some instances microphotographs, all of which add much to the interest.

Second:—Who can join? Any active student or user of the microscope who is willing to abide by the few necessary rules of the club, providing he is reasonably conveniently located relatively to some already established circuit in which there is a vacancy, or near a sufficient number of others desirous of becoming members, so that a full circuit might be formed.

Third:—How? By writing to the resident manager, Dr. R. H. Ward, Troy, N. Y., for the necessary application blank, which requires the applicant to be recommended by one or two members of the club. The membership fee is one dollar, and the annual dues the same.

Fourth:—Who are the officers? The following names of the principal officers are taken from the annual report for 1888:—President, Rev. Samuel Lockwood, Freehold, N. J.; Secretary, Rev. A. B. Hervey, Taunton, Mass.; Assistant Secretary, Henry B. Ward, Troy, N. Y.; Treasurer, Joseph McKay, Troy, N. Y.; Managers, Dr. R. H. Ward (resident), Troy, N. Y., and C. M. Vorce, Cleveland, Ohio.—D.

NOTES.

A Microscopical Laboratory.—The St. Louis College of Pharmacy, with Prof. H. M. Whelpley in charge of microscopy, offers exceptional advantages to all who wish to engage in microscopical work. A laboratory has been liberally fitted up, fully equipped with microscopes, microtomes, microscopical accessories, and mounting materials, so that all the various methods of preparing and mounting substances can be properly taught. No such opportunity to learn this fascinating and important branch of study has ever before been offered in the West, and the classes have always been enthusiastic in their appreciation of the advantages they have enjoyed.

Classes are formed at the beginning of the session, and as each class is limited to twelve students, second, third, and fourth classes are formed as the number of students may demand. Each course of instruction consists of ten lessons of two hours each. Classes meet in the evening.

The first course of lessons embraces the following subjects:—Review of the principles of optics as applied to microscopical technology; structure and use of microscope and accessories; use of mounting appliances, materials, solutions, reagents, etc.; preparing sections, grinding, cutting, bleaching, staining, etc.; making the various styles of dry, transparent, and opaque mounts; mounting in balsam and in glycerine jelly, and special media; mounting in fluids; drawing and measuring objects; determining magnifying power of simple and compound microscopes, etc.

We cannot overestimate the importance of pharmacists making use of an opportunity of acquiring proficiency in this branch of study, which is a fundamental requisite for

the study of modern pharmacognosy, and they will find it not only a source of much enjoyment, but also of pecuniary advantage in after life, as has been demonstrated by graduates of the college.

An advanced course is given for the benefit of those who desire special instruction and practice in vegetable histology, microscopical detection of adulterations, microscopy of the pharmacopœia, etc.

The fee for each course, ten dollars, includes pay for all mounting materials, etc., except slides and cover glasses, which each student must provide for himself, a supply costing about seventy-five cents. Persons not students of the college who desire to join any of these classes may do so by paying the matriculation fee, in addition to the tuition fee for the course.

No text-books are necessary, but any of the standard works are useful for reference. The advanced-course students will be given access to a large library of works on microscopy and its application to the sciences.

The St. Louis Club of Microscopists is composed of persons who have taken the microscopical laboratory instructions, and the students of each class are invited to attend the monthly meetings of this organization.

The Royal Society of England has elected to be foreign members Prof. E. F. W. Pflüger, of Bonn, and Prof. Julius Sachs, of Würzburg.

MacMillan & Co. announce in June that they have in press a Text-Book of Pathology, with illustrations by D. J. Hamilton, to be issued in September; also, The Bacteria in Asiatic Cholera, by E. Klein.

Dr. W. K. Brooks, of Johns Hopkins University, has been appointed a naturalist of the U. S. Fish Commission by Col. McDonald, and he has been given the use of one of the vessels belonging to the Commission for investigations upon the animals of the Gulf Stream.

Prof. Roland D. Irving, of the U. S. Geological Survey, died on June 2. Though only 41 years of age he was a master of his science. He has done a great deal of work upon the copper-bearing rocks of the Northwest.

Christian Science, so-called, has received a rebuff in Massachusetts, where the death of a daughter of a woman practitioner resulted from the culpable neglect to use the ordinary medical reagents. Such infatuation reflects no credit on the cause of progress, and certainly none upon Christianity. It has broken up a happy home, and made its chief ornament a hurt to society.

National Museum.—A bill is at present before Congress appropriating $500,000 for the erection of an additional building for the National Museum. The proposed building is to cover an area 300 feet square, to be two stories high, and to stand flanking the Smithsonian building on the west as the present building does upon the east.

The Discoverer of Chloroform.—Dr. Samuel Guthrie is alleged by Mr. O. Guthrie to have been the first discoverer of chloroform, and the Historical Society of Sackett's Harbor, N. Y., is about to erect a monument to his memory. The claim to priority is based upon a paper published in *Silliman's Journal* in October, 1831, but written prior to May of the same year. Soubeiran, a Frenchman, and Liebig published similar but independent papers, the former in January, 1832, the latter in November, 1831.

Metrology.—Prof. Marshall D. Ewell, of Northwestern University, Evanston, Ill., writes us that he has secured Prof. W. A. Rogers' very perfect dividing engine, with which he has hitherto made his micrometers, and that he shall have it set up ready for use by August 15, making stage or eye-piece micrometers.

Counterfeit Milk.—An Iowa milk company has been detected in furnishing a milk which is artificial, but a very successful imitation of the true bovine emulsion. The report of a St. Louis chemist says:—'It is a perfect imitation in every respect, and nothing but a chemical analysis would discover its true character. It is apparently rich and wholesome, and pleasant to the taste.' A table shows the chemical composition of the milk and of the Iowa company's article. In the latter the proportion of water is larger than in cow's milk, although this is a variable quantity. The chemistry of the product is not well worked out yet.

MICROSCOPICAL SOCIETIES.

ESSEX COUNTY, N. J.—F. VANDERPOEL, *Secy.*

April 12, 1888.—Meeting held at the residence of Dr. J. S. Brown, Montclair, who had prepared an elaborate paper, with the coöperation of Mr. Crosby, upon the 'Practical Normal Histology of the Human Skin.' The Doctor spoke of the skin as being composed of three layers:—the epidermis, cutis vera or corium, and subcutaneous tissue. It is modified in structure so as to adapt it to the various uses to which it is put, being thicker on some parts of the body than on others. The different layers, their structure and peculiarities, were finely shown upon the screen by means of upwards of two hundred slides, some of the sections being less than $\frac{1}{750}$ of an inch in thickness. Some of the slides illustrated the non-nucleated cells of the epidermis. Others showed in a beautiful manner the Malpighian layer. The stratum lucidum was shown in some as a well-defined line, and in others the pigment, which colors the skin of some races, was shown to be in the stratum mucosum. The latter slides contained sections of skin from the negro race, and it was stated that the coloring matter contained iron, which had been derived from the hæmoglobin of the blood. These sections were all well cut and mounted, and were highly satisfactory. Some of the slides contained sections, both transverse and longitudinal, of fœtal fingers, showing the position of the nail, nail bed, root of nail, matrix, end of phalanx, etc. The appendages of the skin were also described. Exhaustive descriptions of the component parts of the hair, its position and growth, the membranes lining the sheath, the medullary and cortical positions of the shaft were given and illustrated, each with suitable slides. A vote of thanks was tendered to Dr. Brown and Mr. Crosby.

NOTICES OF BOOKS.

A Manual of Physiology. A text-book for Students of Medicine. Girard F. Yeo. 3d American Edition. Philadelphia. P. Blakiston, Son & Co. 1888. pp. 758, 319 ills.

It is a pleasant task to look through, for purposes of review, a work like the above. One might suppose that in the present day text-books of physiology were too numerous to make it possible that a new good one should be written, which should not repeat the many already in the market. The masterly work of Foster, which stands unquestionably at the head of all English works of the kind, is too full for the easy use of any but the special physiologist. Clear it is beyond any dispute, but it is better adapted to the wants of highly advanced students than of those in lower grades. It moreover lacks diagrams and figures upon the histology which are most helpful to a qeginner. In the work of Dr. Yeo the anatomy is kept constantly in sight, as well as the histology, and the subject made as definite as possible by the omission of matters under dispute. The work is not historical, but a very clear exposition of the present standpoint. The order of treatment is after the general review of the facts of cell structure, aggregation to form tissues, and a review of the chemistry of the body, and of the food, a thorough survey of digestion, circulation, respiration, secretion and excretion, nutrition and animal heat, muscular action, nervous action, special senses, central nervous system, reproduction development.

While we like the order of treatment in general, consider the digestive system a good place for the start with circulation and respiration after, we should prefer to treat secretion in connection with digestion since it is there that the most extensive secretions are treated, viz:—salivary, gastric, puncreatic, hepatic, etc. But we especially disapprove of the treatment of the general physiology of the nervous system, and special physiology of the peripheral nerves before that of the special senses, followed by that of the brain and spinal cord. Our choice would be to treat the special senses last, and the central nervous system first. The features of especial excellence in the book are full treatment of the embryological portion, and the very clear histological subjects. The histology we take to be of the greatest importance in giving the student, and particularly the medical student, the information he ought to have to locate exactly the trouble in disease. The early chapter on the living cell and its peculiarities is a chapter of great value as an introduction to the later histological portions of the book. Protoplasm being the living substance of the body, and medicine the study of those

environments which harm it, a medical work to be of scientific value should, so far as the present state of knowledge permits, keep it constantly in view. Our author, realizing this fact, emphasizes it in these words :—' The full comprehension of the function of this substance (protoplasm) lies at the root of the greater part of physiology.' To make medicine a science this motto must be at its foundation, otherwise it remains, as it has necessarily been in years gone by before protoplasm had been guessed at and studied, the mere mastering of numerous empirical cures, whose operation was only known by their results. It is, of course, well understood that the science is in its infancy as yet, and it will be long before the healing science can become one of precision. Only second in importance to the continual reference of physiological action to its real seat, the protoplasm of gland muscle and nerve, is the history of these active tissues and their embryology; it is very probable that the future of medicine will find a vast new territory as this subject becomes more clearly understood. Meanwhile the student of physiology should be trained in this as a part of his course. Dr. Yeo has given this subject a fuller study than usual.

It is not only the student of medicine who will use this work, but the general practitioner or general reader in any sphere will find it a most excellent treatise on the subject. While written particularly for the medical student, it fairly comes within the range of any reader who wants to know how his body is constructed, and we gladly recommend it to all our readers. The illustrations are very commendable, as to execution, but more particularly as to design, and with their help we do not see how any one who gives the highly complex subject honest study can fail of comprehending the author's meaning.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

OFFERED.—Diatomaceous earth from Thibet, various localities (12,000 feet); also, material and slides of diatoms from Scottish Highlands, and continental foraminiferæ. WANTED.—Slides of American diatoms, insects, or botany. W. D. STEWART, 2 Gilmore Terrace, Edinburgh, Scotland.

OFFERED.—Sections of vegetable ivory and slides of crystalized maple sugar. Good mounts taken in exchange. WM. LIGHTON, 106 Fifth Avenue, Leavenworth, Kansas.

WANTED.—Parasites and books on Parasites and other micro. subjects. Will give Anatomical, Pathological, Botanical, Micro-fungi, Zoophytes, Polycistinæ, Foraminifera, Parasites, and other slides in return. FRED. LEE CARTER, Gosforth, near Newcastle-on-Tyne, England.

Wanted, Diatomaceous earth from Mégillanes, Bolivia, South America. Can give in exchange either Diatomaceous earth from New Zealand or cash. E. MICHALEK, I. Fleischemarkt, No. 1, Vienna, Austria.

Mounted sections of Fœtal Lung (5 months), sections across entire lobe, $\frac{1}{3000}$ in. thick, beautifully stained, in exchange for first-class pathological slides. W. C. BORDEN, M. D., U. S. A., Fort Douglas, Utah.

Wanted, earths, recent diatoms, and miscellaneous objects for mounting. Only first-class material offered or desired. MARY A. BOOTH, Longmeadow, Mass.

Fossil Diatomaceous deposits (marine) wanted from Bermuda, Virginia, Maryland, California, etc. I. ELLIOTT, Ardwyn Villa, Aberystwith, Wales, England.

Labels for slides. EUGENE PINCKNEY, Dixon, Ill.

Correspondence relative to exchange in microscopical material or prepared mounts. HENRY L. OSBORN, Hamline, Minn.

First-class Histological Slides for other good mounts; Histological and Pathological material cut on shares. S. G. SHANKS, M. D., 547 Clinton Ave., Albany, N. Y.

FOR EXCHANGE.—Strichnia Chromate (Strichnia $\frac{1}{250}$ gr.) and Strichnia Ferri-Cyanide (Strichnia $\frac{1}{100}$ gr.) Will exchange for other slides, Botanical preferred. Only first-class slides offered or desired. L. A. HARDING, Fergus Falls, Minn.

Notices.—All communications for publication should be addressed to Henry Leslie Osborn, Hamline University, Hamline, Minn.

Subscriptions, and all matters of business, should be addressed to Chas. W. Smiley, P. O. Box 630, Washington, D. C.

Subscription price $1.00 PER YEAR *strictly in advance. All subscriptions should end with the December number.* A pink wrapper indicates that the subscription has expired. A date on the wrapper indicates the month to which payment has been made.

Orders for slides advertised by A. J. Doherty in the Journals from January to April, 1887, may be sent through P. O. Box 630, Washington, D. C.

A few copies of Leidy's Fresh-Water Rhizopods, of North America, can still be had at $5.00 per copy.—P O. Box 630, Washington, D. C.

Remittances should be made by postal notes, money orders, or by money sent in registered letters. Drafts should be made payable in Washington, New York, Boston, or Philadelphia.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the following prices which are net:—Vol. II (1881) complete, $1.50; Vol. III (1882), out of print; Vol. IV (1883) complete, $1.50; Vol. V (1884) complete, $1.50; Vol. V (1884), Nos. 2–12, $1.00; Vol. VI (1885), $1.50; Vol. VII (1886), $1.00; Vol. VIII (1887), $1.00. As calls for Volumes I and III sometimes occur, those persons having copies to dispose of would do well to inform us, and to state their prices.

THE AMERICAN

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MICROSCOPICAL JOURNAL.

VOL. IX. **SEPTEMBER, 1888.** No. 9.

The nature of Protozoa and the lessons of these simplest animals, with an account of what has been done in America to elucidate the group.*

BY PROF. D. S. KELLICOTT,†

BUFFALO, N. Y.

In accordance with well established precedent, and by your kindness, it is my privilege to address you this evening hour of the first day of the annual meeting. In making choice of a theme I have been guided largely by the safe examples of my learned and distinguished predecessors who have addressed you on similar occasions, and who have preferred to discuss topics pertaining to their special fields of research rather than to present a general review of the progress towards the perfection of the microscope and its accessories, or to the mass of varied research with the instrument. The President last year, at Pittsburg, in beginning his address, said:—'Microscopy is more nearly cosmopolitan in its character than any other science. If I did not believe this I should not have consented to occupy this honorable position which I now hold by your suffrages. I suppose I am indebted to this expression of your confidence on account of the use which I have made of the microscope as an essential factor in a single line of research.'

Likewise I am pleased to think that I owe my present position, first and partially, to the fact that for six of the ten years of the Society's existence I have been intimately associated with its work as secretary, and second, but may, I hope, chiefly, since in one line of research with the microscope, I have succeeded in bringing to light some forms of minute beings, invisible, indeed, to the unaided eye of man, some of them peculiar and hitherto unknown, whilst others had not been previously announced as occurring in the remarkably varied and interesting microscopic fauna of our native fresh waters. So it seems to me entirely appropriate that on this occasion I should not go outside the line of research to which the greater number of my contributions to the proceedings have pertained; moreover, it is the branch in which you know me best as a naturalist and concerning which I feel some confidence to speak in your presence. Hence, I shall ask your attention for this hour to a general discussion of the nature of Protozoa and lessons of these simplest animals, followed by an account of what has been done in America to elucidate the group. But before proceeding with this subject permit me to extend somewhat these preliminary remarks.

The American Society of Microscopists, like kindred societies everywhere, is composed of those who use the microscope in many and widely different branches and activities; the most useful instrument of investigation yet dis-

*Annual address before the American Society of Microscopists, read at the Columbus meeting, August 21, 1888.

†Recently elected to the chair of Zoology and Comparative Anatomy in the Ohio State University.

covered by the patience and genius of men is the common bond of union; it unites those having little else in common save an enthusiastic love of truth, and naturally it gives name to these organizations. All who depend upon the powerful aid of the microscope are intensely interested in its improvement and its final perfection. Moreover, the improvements in the methods of its use and the complicated and delicate operations necessary to its fullest revelations are of scarcely less importance. The microscope and all that pertains to it, its manipulations and the many refinements of methods of research into the constitution of the minute are, therefore, plainly the first subjects to be considered as the especial province of this Society. These should, unquestionably, receive first place in its deliberations.

This matter was forcibly put four years ago, by Judge Jacob D. Cox, in opening the Rochester meeting of the Society, and quite recently Rev. W. H. Dallinger, President of the Royal Microscopical Society, has expressed similar views. The opinions of these representative men cannot be lightly set aside nor their advice neglected. Their conclusions are the results of rich experience in affairs. The wise man, it is said—and is it not also true of organizations of men—is one who profits by the experience of others; the foolish, who gains by his own experience only. Is this Society in danger, or is it likely to drift into that unhappy state of forgetting 'That in proportion as the optical principles of the microscope are understood, and the theory of microscopical vision is made plain, the value of the instrument over every region to which it can be applied, and in all the varied hands that use it, is increased without definite limits?' The records will show, I think, to any inquirer that the chief reason for the Society's being has been remembered thus far in its history, and the wise councillors and guides which it fortunately possesses give confidence that it will not in the future depart from its safe traditions. The Society has discussed and published numerous papers on the theory and construction of the microscope, new forms, improved methods and devices; it has taken measures, equalled by no other society, to secure a standard of micrometry, it has sought to secure uniformity of tube diameter, improvement in eye-pieces, in the society-screw, etc. Again, besides the papers on microscopy, at every meeting there has been a free exhibition of instruments of the latest forms made at home and abroad, and annually, beginning with the Chicago meeting in 1883, there has been, in addition, a thoroughly organized, practical session or sessions, at which many difficult operations have been explained and demonstrated by those fully competent to teach. The Society then surely has not fallen into the grave error of neglecting microscopy for the discussion of the results of microscopical research. And may it ever be kept in mind by those who direct its energies that the improvement of the 'prince of instruments of investigation' and the technics of its applications are the chief aim, work, and destiny of this still young and progressive organization.

But how justify my choice of a theme for this evening? First, by the ...sage of the most renowned microscopial society, the Royal Society of Lond...n, the proceedings of which are largely concerned with natural history; sec...nd, the custom of this Society which has grown up in accordance with the w...shes and advantages of its members; and third, it seems to me there are g...ood and sufficient reasons why this Society should continue to receive and pu...blish, for the present at least, the results of microscopical investigations by its members in whatever field. 'Wherefore by their fruits ye shall know them.' Methods and means are judged by establishing results tested by comparis...ons and discussions; such conclusions are verities, the flesh and blood th...at clothe and beautify and nourish the skeleton, which in turn gives form, sta...bility, and efficiency to the whole.

If the foregoing precedents are not worthy to be followed, or if there are not the good reasons alleged for occupying your attention as a society of microscopists with such subjects as that announced, then I have, through an error of judgment, fallen short of the full measure of my opportunities on this occasion.

In the following discourse I have endeavored to keep before me these conditions:—1, to mention only such points as reasonably possess a general interest, reserving the more technical results of my study for presentation at the daily sessions; 2, to state and illustrate these facts clearly; and, 3, to occupy a reasonable time.

There is an almost universal desire on the part of the devotees of any particular art or science to date its origin in the remote past. Are we not apt to esteem most highly that which bears the stamp of hoary antiquity? I am convinced that this is the case; and yet I cannot justly claim that advantage for my specialty. Other reasons must be alleged as a warrant for especial attention to it. Still, the beginning of our knowledge of the simplest animals was laid more than two hundred years ago. The microscope of that time was indeed a primitive instrument. Its evolution had so far progressed that it was something more than a toy. By its aid at that time was revealed, in partial vision it is true, the grand fact that there exists beneath the waters of every mantled, festering pool or limpid stream, in lake or river, or in ocean depths alike, myriads of invisibly minute beings, ceaselessly, noiselessly pursuing their work unheeded. As the infinite variety of graceful forms and their strange habits were more and more clearly comprehended, and as the knowledge of a newly-revealed animal world increased, the enthusiasm of these early microscopists became exuberant, and with their enthusiasm grew their devotion to nature and its Author—a consequence repeated in every student who in the right spirit learns her lessons for himself by his own explorations. Men now possessed, and were beginning to employ, constantly-improving microscopical vision. It revealed a world of minute animals and plants, perfect in their way, actuated and governed by principles and impulses not unlike those controlling the macroscopic already known. In these animate atoms were seen anew, or for the first time, certain world problems, and there sprung up fresh hope of their solutions. The origin and nature of life, what guiding intelligence adjusts the varied relations and necessities of each and every minute creature to its environment as truly and exactly as in the higher organic forms. Moreover, here and there a broad, unknown domain of nature was opened for exploration by the human intellect, which, at that time, as it seems to us, was in the attitude of the child toward nature, eager to know its facts and the reason for them; seeking knowledge for the sake of knowing. There is no wonder that the early investigators of microscopic life were enthusiastic; they had abundant reason for this directing sentiment. Their devotion and patience laid well the foundations of the science of a great branch of animals. Leuwenhock, Jablot, Baker, Trembly, Ledermiller, Perty, Muller, and Ehrenberg prepared the way for the brilliant discoveries and broad generalizations of a half century just passed by the renowned students of the simplest living beings. The present knowledge of the Protozoa does not compare unfavorably with that of any other assemblage of animals, and is advancing as rapidly; this, too, when only comparatively few skilled workers can contribute to this end, and, moreover, these forms are of little or no practical use or importance. Even their once supposed intimate relation, as a cause, to many distressing maladies has not been confirmed by recent research, but rather disproved, except, perhaps, in the rare instances of certain blood parasites, or some external parasites of aquatic animals. There is, then, sufficient love of abstract truth, sufficient enthusiasm in bringing to light new facts and endeavoring to

answer grave problems of philosophy, to render possible brilliant discoveries, if not a brilliant scientific epoch. To these sentiments is due our knowledge of and interest in the Protozoa.

The animal kingdom is divided into two natural groups or series—the Protozoa and the Metazoa. The former includes the unicellular forms or those generally regarded as the equivalent of the histological cell; the latter are multicellular, their tissues are composed of histogenetic elements or cells, and these are arranged in two sets, viz., the ectoderm, or outside body-wall, and the endoderm, or lining of the alimentary cavity. These commence existence as a nucleated cell; their subsequent growth and complexity are the result of cell multiplication and modification mingled with the products of cell life. The Protozoa do not pass beyond the primitive stage, *i. e.*, cell division giving rise to individuals. None are modified for the sake of others, and all perform similar functions and all the essential functions of an animal. Truly, then, we have here the simplest forms of animal existence possible, whilst the life of the metazoon may be regarded as the resultant of hosts of individuals comprising it and among which division of labor is fully carried out; on the other hand in the protozoon we see manifested by each individual only the capabilities of one element. In this case, then, we deal with the absolute elements and not with resultants. Here the mystery of mysteries seems to be almost unveiled. The nature of life, if it is to be revealed by the study of organisms which exhibit it, should appear from the study of the naked, disassociated protoplasmic atoms in which all the essential attributes of life are manifested. The simplest of these, for they differ widely among themselves, are without nerves; yet they are sensitive—they are without organs; yet they move about freely, gather, select, and digest their food, and escape from their enemies; they reproduce their kind, and maintain themselves when subjected to unfavorable conditions with as great certainty as do the complex and bulky animals. In short, their life histories, as we get to know them better, prove to be as definite, the specific characters as constant. But does the clearer understanding of these forms in their simplicity shed light on the nature and origin of life which are held by many savants not to be transcendental? It seems to me not, and that we are still very far from the solution of these great problems. The most that has eventuated thus far is a shifting of the point of view. This has undoubtedly afforded a clearer sight; but the perfect is not revealed. Still, whilst the object sought may be illusive, and, as one who pursues the rainbow finds it ever a few steps beyond his reach, so here, the answers to the questions mentioned, which have been so eagerly sought for in the bodies of the simplest and beginning forms of life, ever elude the microscope and reagents of the inquirer. Then are we no nearer an understanding of these matters than before? Most certainly we are. The problems of human society are not nearly all solved, but there have been tremendous strides in advance since the individual has been made the object of consideration rather than communities. Although the results attained are so far short of hopes and expectations, yet, in the prosecution of these inquiries in connection with Protozoa there are fascination and interest. Further than this their infinite variety, their gracefulness of form and motions, their ubiquity and high endowments, coupled with simplicity, firmly hold the attention of the student.

For the sake of clearness in the subsequent parts of this discourse let us attend for a few minutes to the organisms themselves and the terms designating the parts. (To aid in this explanation simple figures were drawn on the black-board.)

A cursory survey will disclose the fact that there exist very great differences among those creatures comprehended in Protozoa. The reach from the low-

est to the highest is immense, comparable only to a corresponding relation between highest and lowest vertebrates; hence, for illustration of terms and for convenience of comparison, I have chosen a species near the middle of the series. With this we may hurriedly and easily compare others, higher and lower.

If to a beaker of clear water a few fragments of hay be added and let stand a few days there may be found in the infusion great numbers of a small animated speck represented by the sketch. A careful study of this object has revealed interesting facts and suggested inquiries not yet fully answered. It is somewhat egg-shaped or globular, quite soft and elastic, with two similar external appendages consisting of two long lash-like fibres. Under the lens the whole organism appears endowed with life. This is attested by its free motion, sensitiveness, and ability to appropriate and change to voluntary activity the energy of organic food. The proper tests prove that its substance is identical with that form of matter everywhere associated with life and called protoplasm. In fact this animal is little else than this remarkably complex and wonderful substance now universally recognized as the physical basis of life.

This minute lump of matter, only about $\frac{1}{4000}$ of an inch in diameter, is naked protoplasm. True, its outer boundary appears to be somewhat denser than the portion included; still, it appears that its food may be taken directly through the surface at any place; there is not a food receiving orifice—a mouth. On examining the globule farther two important bodies attract our attention. First, imbedded in the protoplasm may be seen a globule of protoplasm firmer than the surrounding mass; this is the nucleus. This element of the protozoan body, possessed also by the histogenic cell, has elicited much study and animated discussion. Almost every issue of the microscopical and morphological journals bring to notice accounts of new and many far-reaching discoveries regarding it in relation to the career of the cell to which it belongs; second, within the endoplasm may be seen a clear globule which grows until a certain size is attained, when a sudden collapse occurs and it disappears to again steadily form and disappear as before. The two lashes which arise from the lower anterior part of the body are extensions of the body protoplasm, hence possessing its properties of sensibility and contractility. One of these flagella reaches ahead, and by its repeated strokes against the water pulls the body through that medium; the other is used as a director of its course, or sometimes as an anchor. These few differentiated parts are all that characterize this representative of one of the great classes of one division of the Protozoa, viz., the Flagellata, the first class of the Infusoria. By variations of these parts and their products arise those characters and differences on which are established scores of genera that are simpler and scores that are more complex.

That these germs teeming in the hay infusion are alive no one questions. It but why relegate them to the animal kingdom rather than to the vegetable? to s no longer difficult to refer any one of the complex or multicellular beings diffe e or the other of these two parallel series. There are no longer serious divide nces of opinion concerning such among the learned, but to satisfactorily Protol unicellular forms, placing this one among Protozoa, and that one among not ena hyta, is another matter—one which the present state of knowledge does has pro le men to agree upon. The distinguished biologist, Ernst Haeckel, To this i osed to remove the difficulty by establishing a third kingdom, Protista. by him. nany doubtful species and many that are not so have been assigned seems to i He has distinguished followers. Still, to many the proposition questions i grease rather than diminish the perplexity, for now we have two mals on the stead of one to contend with, viz., to separate Protista from ani- one hand, and second, from plants on the other. Again, if I

understand aright the tendency of modern research concerning this matter, the number of forms which cannot be assigned with good reason to either the vegetable or the animal series is constantly growing smaller. In short, it seems to me Protista is gradually tapering to a point as knowledge advances, and at no very distant period there will be no use for it in the sense it was first proposed and limited.

I prefer to keep to the old lines and regard these lowest beings as either plants or animals according to the best light we have. That mistakes will be made for subsequent study to correct must be expected. But that there will be more than by any yet proposed arrangement I cannot believe.

This little swimmer from the infusion of hay is known in the system as Heteromita. Why is Heteromita an animal? 1. It feeds on organic matter of the infusion in which it flourishes. Since it contains in its body none of that peculiar substance, chlorophyl, which enables protoplasm to create its own food out of the simple substances, H_2O, CO_2, and NH_3, in the presence of sun-light. On the other hand it must borrow its substance and energy from other and independent sources.

At this point two questions naturally arise which are in the nature of exceptions:—(1) There are well known and undisputed plants with the habit of animals, *i. e.*, they feed on organic food prepared outside themselves, whilst it is the rule that animals feed, as our infusorian does, upon substance prepared ultimately by plants, and that the plant prepares its own; the Fungi and certain colorless flowering plants reverse the rule and are exceptions. That they have acquired this animal habit will not be difficult to believe if we take into account the prevalence of parasitism and the wonderful changes and modifications of form and habits which it implies. The Fungi are plants, as their life-histories, development, and structure attest. Besides, they may feed on such chemicals as acetates, tartrates, and ammonia; this animals cannot do. (2) The second exception is this:—certain undoubted animals, *e. g.*, the green Hydra, some fresh-water sponges, and infusoria, are perverted by chlorophyl-bearing bodies. These are said to possess the power, therefore, of creating their own food in manner similar to the ordinary plant. It should be noted that if it proves to be true that these green animals have acquired the characteristic habit of the vegetable, another fact is added tending to prove that protoplasm of either kingdom is capable of great accommodation or change of habits.

In regard to the question of the possibility of carrying one's vegetable garden in one's stomach I wish to express a doubt. I cannot see that the species whose tissues are filled with these bodies, and on which, or on their products, it is supposed to feed, possesses an adequate advantage over those not thus supplied. Our green Hydra is not so abundant as the brown one, nor will it hold out longer under unfavorable conditions; it feeds as voraciously. Two masses of fresh-water sponge are often seen growing side by side, one brilliant green, the other colorless, or one mass may be partly green and partly colorless. I am unable to see that the green example or the green part has any advantage over the colorless associate. A particular infusorian Holophyra (which I shall refer to at another time during this meeting) occurs in abundance in a certain sluggish stream near Buffalo. It is a deep green and often imparts its hue to the water and submerged objects in which it accumulates. A number of these were recently taken and subjected to a series of varying conditions, whilst check experiments were conducted with the uncolored *Enchyleodon farctus*. Under varied conditions as to light, temperature, air, and absence of food, so far as I could determine, the green species possessed no advantage as to enduring qualities over the other. The usefulness of these chlorophyl-bodies, if they are useful, is not, it seems to me, in the direction of nutrition or respiration.

2. The second reason why *Heteromita lens* is an animal is the course of its life-history. This is now reasonably well known, and is in accord with those of others that are unmistakably of the animal series.

3. Its contractile vesicle is an attribute peculiar to the microscopic animal. True, a similar endowment has been attributed to species of Protophyta. I am not convinced that such exist, at least of the nature and action of those of creatures similar to *Heteromita*.

4. When the motions and behavior of these mites are taken into account one receives an impression that they are guided by intelligence and a conscious state wholly different from the influences controlling the motions of the one-celled plants. While this is not a high order of proof it should not, I think, be wholly disregarded. It certainly is in constant and instinctive use by those who study these forms.

Heteromita is clearly an animal. How stands the matter with the lowest plasmodic beings? The amœba, *e. g.*, has no definite form; its exterior bounding parts are less differentiated than those of the animal described above. It has no specialized organs of locomotion like this one, while it has a nucleus and contracting or pulsating vacuole. It feeds also on organic particles, which it takes in the solid state indifferently at any part of its body, and it moves about with a freedom and conscious direction that stamp it as one of the animal series. The very small amœba found in our creeks and ponds could not well be less complex and still exhibit the functions of animal life. Dr. Carpenter's often-quoted words characterizing the Rhizopoda aptly describe it:—'A little particle of apparently homogeneous jelly, changing itself into a greater variety of forms than the fabled Proteus, laying hold of its food without members, swallowing it without a mouth, digesting it without a stomach; moving from place to place without muscles, and feeling without nerves.' But there are lower animals, it is said; the *Monera*, for example:—'An organism without organs, which * * * consists of a freely-movable naked body, composed of a structureless and homogeneous sarcode never-differentiating nuclei within the homogeneous protoplasm.' Is this existence plant or animal? For one, I am willing to leave it in 'No Man's Land.' A large number of the simplest forms, once regarded as non-nucleated and without differentiation, are on further study found to be nucleated and otherwise not so simple as at first supposed. *Monera*, it seems, is already limited, and may vanish entirely under the searching scrutiny of recent methods.

So far as the *Monera* is concerned, I have to say I cannot find it. I have ransacked every likely place within my reach at all seasons without encountering such a being. I do not presume to deny its existence because I cannot find it, but I have a sufficiently wide acquaintance with unicellular plants and animals, and with their haunts, to justify me in doubting their individuality, so far as my own general conclusions are concerned. I do not, however, anxiously to speak for others, or to influence them in this matter. Both negative sensuous positive results of my studies compel me to doubt that *Monera*, in the sense in which it was first described, exists, as much as we all to-day doubt the existence of *Bothybius*.

As soon as beings like our *Heteromita* were discovered there arose the pertinent inquiry, whence came they? They had no visible ancestry. A few fragments of dried grass put into a clear beaker with clear water, after a few hours, brought forth living myriads. Was it, therefore, true that these, and others like them, which people every wayside ditch and stagnant pool, came into consciousness and life from the dead by chemical and physical changes therein? It was not necessary to stand upon the belief of such an origin, and yet it was in accordance with the known facts. While mankind was

ignorant of nature, fancy peopled jungle and forest with real and unreal animals spontaneously generated; this, too, was logical. Aristotle taught that this was one of the regular and natural modes for the production of living forms. As knowledge advanced the number of species thus accounted for faded away. After the microscope revealed a new world of minute existences, whose origin was still more difficult to verify, the belief was again strong that these were forms of life without parentage. But one after another of the coarser forms was studied and proved to follow as definite a life-history as the largest animals.

Recent progress in drawing hard and fast lines about the personality of the myriad species of minute organisms leads us to wonder that so late as 1871–2, in the Proceedings of the American Association for the Advancement of Science and also in the New Haven *Journal of Science and Art*, same date, pp. 20 and 88, there appeared a discussion seriously purporting to trace a sequence of forms from *Protococcus* or *Chlamydococcus* to the spirally pedunculate *Vorticella;* then *Oxytricha* and perhaps *Rotifer*.

This is truly imaginative and poetic 'science.' The day for such is almost, but not wholly, gone; but the 'beginnings of life' have served their time, let some other branch hereafter have the honor.

Finally, within the last quarter of a century, largely by men still living, the contention over the spontaneous derivative, more especially of the simplest plants, the Bacteria, has been animated, the experimentation and analysis exact and searching. Undoubtedly, the result has been a disbelief, on the part of a great majority of naturalists, in Archebiosis. On the other hand, there are those who maintain that it is not so much a matter of experiment as a logical sequence of the doctrine of evolution.

Following the astronomer's ideas of the evolution of the earth, there was a time when the conditions were such that life could not exist; afterwards, conditions were favorable, the lowest forms originated spontaneously by the forces of nature, and, from these beginnings, all subsequent hosts, great and small, have been evolved.

The more conservative philosophers who can believe in the spontaneous generation of life only on experimental evidence, are, nevertheless, logical in holding a belief in evolution of plants and animals as a fact, since the natural laws known as Darwinism apply only to already existing conscious forms. To this class the origin of life is a mystery.

Our swarms of Heteromita, then, arose in the nutrient infusion from germs derived from air or water or by clinging to the hay. These germs, in turn, took their origin and potentiality from Heteromitas, infinitely near this one in characters, and so backward indefinitely from another so-called species or an original ancestral form for whose origin science is not able to account.

Admitting the distinct nature of the two parallel series of living beings, derived by the evolutionary processes, from a created beginning, this interesting question arises, *i. e.*, which was first established? As they are found related, one sort depends wholly upon the other for the creation of complex compounds which serve them for food, the source of substance and energy. Unless this dependence of animals is an acquired habit, as the same site acquires habits of feeding upon the substance of its host, and at the same time loses the ability to procure its food independently, the vegetable sentative must have preceded the animal. Paleontology affords no evidence affecting the question one way or the other. The earliest evidence of life in the Laurentian rocks points to the cotemporaneous existence of plants and animals. In the absence of facts men speculate. A certain chemical compound, chlorophyl, seems to be necessary to protoplasm that it may maintain and increase itself. Hence the query, was the primitive protoplasm like that

of animals without chlorophyl or like that of plants supplied with it? An eminent English scientist has suggested the possibility, at least, that animals preceded plants. The following is a statement of his views:—'A conceivable state of things is that a vast amount of albuminoids and other such compounds had been brought into existence by those processes which culminated in the development of the first protoplasm, and it seems likely enough that this first protoplasm fed upon these antecedent steps in its own evolution just as animals feed on organic compounds at the present day.

'At subsequent stages in the history of this archaic living matter, chlorophyll was evolved and the power of taking carbon from carbonic acid. The green plants were rendered possible by the evolution of chlorophyll, but, through what ancestral forms they took origin or whether more than once, *i. e.*, by more than one branch, it is difficult even to guess. The green Flagellate Protozoa (Volvocineæ) certainly furnish a connecting point by which it is possible to link on the pedigree of the green plants to the primitive protoplasm. Thus we are led to entertain the paradox that, though the animal is dependent on the plant for its food, yet the animal preceded the plant in evolution, and we look among the lower Protozoa and not among the Protophyta for the nearest representatives of that first protoplasm which was the result of a long and gradual evolution of chemical structure and the starting-point of the development of organic forms.'

To those who profess to believe in the production by chemical evolution of protoplasm as a specific being reproducing itself, this ingenious 'paradox' is well nigh unavoidable. Chlorophyl is a product of protoplasm and could not well precede in evolution its cause. But this, plausible as it is, depends on too many pure assumptions. It is broached only because it seems to be a logical sequence of a theory which cannot be proved, and of which many dispute even the probability. It must be assumed, first, that there was, in the remote time of primordial life, produced, by chemical reactions alone, a mass of albuminoids from which protoplasm could and did spring, and on which it could subsist until an oncoming sense of hunger, as the supply of organic food produced without antecedent life disappeared, suggested or caused or resulted in the production of chlorophyl, by which means the supply was replenished. Second, the nature and relations of the animate kingdoms, as they now exist, were once different or reversed. Neither of these propositions is sustained by a particle of chemical, biological, or paleontological evidence. The past must be judged by the present. To preserve respect for the scientific method and the conclusions derived therefrom unnecessary speculation should be avoided. For one, I prefer to hold, for the present at least, the belief that in the beginning living organisms were created in their simplest forms; from these succeeding floras and faunas have been evolved.

'We do not begin to know the nature of force, of matter, or the origin of motion, yet we study and investigate their laws and natural relations, and are satisfied. We rest our inquiries as to whence and what, and partly admit that these are questions past finding out by our philosophy. So, too, we may logically examine the phenomena of life, past and present, without being able or assuming to explain on scientific grounds its essence or origin. I am willing to admit the creation of protoplasm, and chlorophyl too, if necessary, by a power that is beyond nature as we understand the term.

Still I admit that the question of Archebiosis is not necessarily and forever settled; it may yet be attacked and proved experimentally by some one endowed by a peculiar genius for experimentation, one who shall be able both to see and to artificially reproduce those conditions and combinations of matter and forces, chemical and physical, which existed during the ages preceding the formation of the oldest fossil-bearing rocks.

Until such genius arises or light breaks in from some other source, I say again, I think it quite as logical and as satisfactory to keep to the old lines, at least so far as to believe that, up to a certain stage in the progress of the material world, there were no living beings, then they were created by an almighty power, not expressed by condition and chemistry. I hold this simply as a naturalist, for consistency's sake, and in order to go no farther than the evidence warrants, so I am free to follow the lead of truth no matter whither it may direct.

The variety of types of the Protozoa is very great. This can scarcely be appreciated except by long and intimate study. There is neither time nor reason for an enumeration of these characters and peculiarities, although it would be interesting to trace the advance in characters. As we proceeded from the highest to the lowest of the groups we should find each type more or less intimately connected with those both above and below; that is, the line of phylogenetic descent is as clearly traceable in the protozoic as in the metazoic branches of the animal kingdom. But this is not all, for we find certain Infusoria, for example, which are evidently the types connecting the origin of the higher groups with the lower. We should also note, often with astonishment, the remarkable capability of the disassociated, specific cell, and, by the proper comparisons, find at every stage that the same functions or attributes persist in the associated units of animal tissues.

The Protozoa are separated into two grand divisions, Rhizopoda and Infusoria. The simplest of the former are naked, possibly reticulated protoplasm only, nucleated and usually with a pulsating vacuole; they lack all specialized organs of locomotion, prehension, or digestion, whilst the most highly specialized Infusoria have their protoplasm surrounded by a firm, protecting, and bounding wall, well defined, and often complexly differentiated apertures for the reception of food; their bodies have definite shape, and their organs of locomotion are well developed. But from the lowest to the highest may be traced such plain biogenetic relations that the development of the highest from lower is unmistakably revealed. Regard, for an example, the sedentary Tentaculifera, the most highly developed of the Infusoria. They give birth to ciliated, free-swimming embryos, resembling closely the adults of one of the three classes of the Ciliata which are less highly organized. This peculiar characteristic in the embryology of the Tentaculifera seems to conclusively demonstrate their higher rank compared with the Ciliata. On the other hand the adults are, without doubt, allied to the Metazoic Hydrozoa, which also have ciliated embyros attesting their ascent from the Ciliata through the Tentaculifera. So not only do the structural peculiarities and developmental phenomena of the unicellular animals plainly teach derivation by biogenetic descent throughout the branch, but also indicate the starting point of various types of the Metozoa. In substantiation of this proposition, it may not be amiss to point out examples in proof. Since the succession of embryonic characters of the higher species appears to trace more or less certainly the ancestral or developmental history of that species, the connecting stages of the two branches of animals are, in many cases, already established. The larvæ of the star-fishes and sea-urchins are free-swimming little bodies, surrounded by bands of cilia which unmistakably disclose the ancestral affinities of the Echinoderms with the Peritrichous Ciliata, the class of Infusoria to which the well-known Vorticellæ or bell animalcules belong. Another illustration may be mentioned. In the intestines of the common frog and toad may at any time be found a flat, mouthless infusorian known as *Opalina ranarum;* it is covered throughout with fine, even cilia. There hatches from the eggs of the Cœlenterata an animal not resembling the parent, but a cilia type, the planula, so closely resembling the parasite from the frog

that only an experienced observer can appreciate the difference. Indeed the great naturalist, Louis Agassiz, so late as 1852, in the *New Haven Journal of Science and Art*, declared that *Opalina* was the missing link in the history of *Distoma*, a genus of parasitic worms, and further, that the embryo hatched from the egg of a planarian (another worm) was a genuine polygastric animalcule of the genus Paramecium. In the same paper he says, referring to the above, 'with such facts before us, there is no longer any doubt respecting the character of the Polygastrica; they are the earliest larval condition of worms.' He adds, also, this:—'Since I have ascertained that the Vorticellæ are true Bryozoa * * * there is not a type of these microscopical beings left which hereafter can be considered a class by itself in the animal kingdom.' These sentences are not quoted to call attention to an error of our revered naturalist, but to show more thoroughly than a mere statement would do the absolute similarity of the ciliate embryos of certain Metazoa to ciliate Infusoria.

The study of Protozoa in the light of the above and for the sake of elucidating such questions of world-wide interest cannot be lightly esteemed.

The simplest Rhizopoda, as stated above, consist of naked reticulated protoplasm. From this unmodified beginning may be traced ever-increasing complexity of structure. The locomotory organs may serve for an example. The uncovered forms move in two ways, by a flowing or streaming of the protoplasm as a whole, or by the protrusion of finger-like processes or threads of the body substance, called pseudopodia, which are transient or held by a permanent firm axis. Their power of extension and retraction render them organs of locomotion and prehension.

The corticated forms have, protruding from the surface at well defined regions, thread-like extensions of the protoplasm, called, if but few in number and relatively very long, flagella, and cilia if numerous and relatively short. These, by lashing the medium, propel the animal, or, if anchored, drive currents past the oral aperture; whilst in the highest divisions the cilia are replaced by styles or setæ which act very much like walking organs, and in the still more highly endowed Tentaculifera the prehensile prolongations of the body substance are tubular, usually with sucking disc at the extremity, and, often, with a spiral coiled fibre for its retraction.

A still more highly specialized instance occurs in certain ones of this group in which the tentacles become marvellously flexible. This is notably the case in *Ephelotida* and in *Podophrya flexilis*, a fresh-water species described by myself in *The Microscope* for August, 1887. In this form, the long, extensible and constantly writhing arms remind one of a veritable Octopus.

Another equally instructive series is that of the manner of and contrivances for food ingestion. In the simplest forms this takes place by simply engulfing it; a little higher in the series it is received through the body walls at restricted areas; then a well defined and guarded aperture is found, often reinforced by a wonderfully complex system of chitinous or otherwise indurated appendages, or it may consist of sucking tubes, sometimes flexible. But enough of these details, which have been enumerated not only to show the mutual relations of the groups which result from the fact of descent from common ancestors, but to present certain terms by which to make easy the explanation of the persistency of protozoic functions in the associated cells of the tissues of multicellular animals. Thus the amœboid motion of the colorless blood corpuscles and other cells, the contractions of the muscle cells, the cilia of the epithelium of the trachea and ventricles of the brain are examples.

The Protozoa, lowly as they are in organization, and insignificant in size,

have from the dawn of animal life on the earth to the present played a leading part in the great problems and progress of the world. Biological evidence is irresistible in proof that the first manifestation of animal life was protozoic; that the capabilities of development on this type were finally exhausted, and that there radiated from the protozonic line, at different stages, certain metozoic types. All through the ages of change they have kept persistently to their work. The heat and drouth of summer or the frosts of winter cannot destroy them; when the water of the transient streams disappears or food fails, they simply wrap about their frail bodies an impervious mantle to retain their own moisture and fall asleep until returning favorable conditions restore them to activity; then again the battle of life goes fiercely on beneath the surface. Each feeds ravenously upon unicellular plants, mercilessly on those of its kind smaller than itself, and in turn is destined to be swallowed by one that is larger. Notwithstanding this inevitable destruction, their prodigious powers of multiplication and reproduction ever maintain them against the vicissitudes of climate or the distress from enemies. This invisible link uniting the animal to the vegetable, and this to the mineral, incessantly at work, is found everywhere that moisture abounds.

Saville W. Kent has gracefully said:—'Inappreciable individually to the unaided vision, the countless hosts of the Infusorial world, more familiar, perhaps, to the popular mind under the designation animalcules or animalcula, surround us literally on every side. They abound in the full plenitude of life alike in the running stream, the still and weed-grown pond, or the trackless ocean; nay, more, every dew-ladened blade of grass supports its multitudes, while in their semi-torpid encysted or sporular state they permeate as dust the atmosphere we breathe, and beyond question form a more or less considerable increment of the very food we swallow.'

But it is not altogether the invisible and theoretical that challenge our attention and admiration; mountain masses of limestone are their enduring monuments. From the warm seas of remote geological ages to the cooler seas of the present they have been separating from sea-water the carbonate of lime and fixing the carbonic acid gas until it is manifest that they have done more than all other life towards preparing the present state of the modified crust of the earth. At the same time they have recorded in the rocky volumes by their entombed shells much of the history of the past.

This Society of microscopists has from the first kindly received, discussed and published contributions to our knowledge of the various groups of the simplest plants and animals; hence, it seems appropriate to briefly enunciate some of the chief problems, pertaining to the Protozoa, which are open to us for investigation—problems to the solution of which the future work of the Society should contribute. Obviously, the first works to be accomplished by American students of the group are the identification of the species, naming, describing, and figuring the new species and genera, recording the distribution and habitats, and the presentation of the same in available publications. It is with pleasure and pride that we justly claim that in these lines the work is going forward vigorously, although the number of students is limited, and, thus far, almost exclusively restricted to fresh-water and parasitic forms. The results already recorded plainly show that the protozoic fauna of our inland waters is extremely rich, presenting many characteristic and peculiar species. Many of our numerous species are undoubtedly identical or differ but slightly from European species, so slightly that I have not considered them of specific value, whilst many more are perfectly distinct. Dr. A. C. Stokes, who has described more of our species than any one else, has said that the species in the sphagnous swamps of New Jersey are mostly new. The many unique forms he has brought to light appear to justify the conclu-

sion. There remains to be explored the waters of our extensive coast and the greater part of our vast inland waters. When this has been accomplished as thoroughly as it has been done in Europe the number of species in the catalogue will be enormously increased. Then, again, there are whole groups which have well nigh escaped observation, for example, the Proteomixa of Lankester, a group at the very threshold of organic life, studied by leading biologists of Europe, but almost wholly neglected or overlooked in this country. A few of the species have been rediscovered; but aside from the additions by Dr. Joseph Leidy scarcely no new data have been added to the recorded knowledge of the branch. Dr. Leidy has given us in Rhizopods of North America (1879) an admirable summary and treatise of the Rhizopoda, which, with the available manuals and reports, give our students of the Rhizopoda a fair basis for work. In the field of Infusoria there is equal advantage afforded by the Manual of Kent, the magnificent treatise of Stein, the comprehensive work of Butchli, now issuing, the papers of Enz, Maupus, and others, and the recent summary of American species, both described and identified by Dr. Stokes. So, at last, the books necessary for progress are to be had by our students; we have the microscopes surpassed by none; what, then, is lacking? Methods and determination that enter the mind as an influence. Our university biological laboratories do very little in this line, the ordinary schools nothing; therefore zoölogical stations, summer biological schools, and scientific societies may justly be called upon to foster this department of research by teaching its methods.

The discovery and description of species, although necessary and naturally first in order, are not the most important or most fascinating parts of the investigation. The biological history and habits of species, their food and relations to other species, are not less worthy of the student's attention. There are still many unanswered questions as regards their anatomy and physiology. Among these may be mentioned the following:—The nature, behavior and significance of the nucleus, the nervous system, the reticulation of the protoplasm, holophytic nutrition, the nature and action of the trichocysts, the passage from host to host of parasitic species and their pathological influence, the nature and function of the contractile vacuole, the production of shells and cysts, and many more.

I cannot consent to close without alluding to the excellent work of American students of the Protozoa already to our credit. We all know Dr. J. W. Bailey as a pioneer in American Microscopy; as one who required a high degree of excellence in the microscope and was able to obtain from it its very best performances, and who did much toward fixing a high standard for our opticians and investigators. He was an industrious student of minute types of life, and the first, I think, to publish original observations on the Protozoa in this country. His papers relating to these organisms occur in the Smithsonian Contributions to Knowledge, beginning in 1849 and continuing to 1855. These consist of species identified, with descriptions of a few species of Rhizopoda and Infusoria. In connection with the first list is also one by Thomas Cole. Dr. Bailey remarks, 'Mr. Cole is, I think, the first in this country to make a systematic study of the soft skinned Infusoria.' Both lists contain the names of species which are among our most interesting ones.

Undoubtedly the most brilliant discovery thus far stands to the credit of Prof. H. J. Clark. He was a student, and, I think, an assistant of Prof. Agassiz; with the presence, necessarily, a thorough investigator. Not feeling satisfied with the performance of the objectives made for Prof. Agassiz by Oberhauser, and Spencer and the best to be obtained of that maker, he secured those by C. A. R. B. Tolles. With these he was able to demonstrate structure

in the Protozoa not previously suspected. I refer principally to the discovery in 1868 of the 'Collar' of certain flagellate monads. This was a triumph for for American objectives as well as for an American naturalist. The many beautiful forms discovered in the last two decades now constitute the order Coano-Flagellata. He also discovered at this time that the tubular passages of sponges were lined with similar collared monads; hence he announced the protozoic nature of the porifera; a proposition with which but few naturalists at present accord. This is mainly, it seems, because the supposed embryology of the sponges allies them to the Metazoa.

If these phenomena are finally interpreted differently the sponges may yet be relegated to the Protozoa. So far as the fresh-water representatives are concerned, excepting the so-called embryological characters, they appear to be protozoic; especially since the discovery of *Proterospongia*, a genus of undoubted Coano-flagellate monads which secrete a mucilaginous matrix for the shelter of the colony. Representatives of the genus are known both in Europe and America.

The Monograph of the North American Rhizopods by Dr. Leidy has been mentioned. Besides this excellent work he has published many papers on Rhizopoda, Gregarinæ, and Infusoria. Most of the infusorian species are parasitic in the intestines of insects and worms.

The foundations of the science are well laid. There are now greatly increased facilities for study, so that earnest specialists are now able to advance our knowledge of these forms rapidly and with credit to our science. I will omit further mention of specific work, reserving the same for an appendix to this article.

I am intensely interested in the lowly creatures to which I have asked your attention, and I hope they are not wholly devoid of interest to any of you. The exactions of the occupation of an American school teacher leave comparatively little time or energy for private study or investigation. The few hours each week that I can get I devote to the refreshing pursuit of natural science. It has come into my life as an influence as it has to many others. It seems to me, and I am led to the conclusion by observation as well as experience, that the influence of no other specialty is so edifying and enduring. The Protozoa have afforded me for the past few years the most available opportunities for that communion with nature that is both fascinating and satisfying. I can heartily recommend these beautiful objects, so wonderful in their simplicity, to any who seek a special field of natural study. In conclusion I will quote a paragraph from Dr. Leidy, expressing beautifully the experience of every true fisherman:—

'Going fishing? How often the question has been asked by acquaintances as they have met me with rod and basket on an excursion after materials for microscopical study. Yes, has been the invariable answer, for it saved much detention and explanation. * * * No fish for the stomach, but, as the able old French microscopist Jablot observed, "some of the most remarkable fishes that have ever been seen;" and food fishes for the intellect.'

Aquarium microscope.—Mr. C. Collins reports a novel form of microscope for observing the life in an aquarium. A sucker apparatus, made by a rubber ring with a central piston, is fastened directly to the side of the aquarium and the microscope is supported by a rod through the sucker, which apparatus is securely fastened to the body-tube.

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Quinine or chloral.—In slight doses, as used by Hertwig in the study of Spermatozoa, it stopped their movements, which returned on the addition of water. Could this not be used for Protozoa?

A decayed nut.

By V. A. LATHAM,

ANN ARBOR, MICH.

A short time since, while eating Brazil nuts, I found one which, though it afforded no stimulus to the appetite, at least furnished food for the mind. It was a decayed nut, the kernel being completely decomposed. In place of the solid, oily kernel only a few particles of oily and sugary matter were found. This led to reflection, and the determination succeeded to submit it to the microscope. Thinking that it would be desirable, first, to know the component parts of a healthy nut, I procured a portion of the brown, scaly covering with which the nut is invested. This was, as anticipated, an epidermis of simple membrane covering the albuminous matter which composed the kernel. When placed in a drop of water and viewed with a power of 50 diameters it was seen to be distinctly cellular in appearance, the cell markings closely assimilating those of the flattened outer epidermal cells of the human skin. Hence I concluded it was made up of flattened cells. Viewed with oblique light its markings were distinctly seen. I next made a very thin section of the kernel and found it to be cellular in structure, exhibiting well-defined cell-walls composed of a tough, rather opaque substance, in shape somewhat oval. Here and there in the field of view were globules of oil, with their well-defined rings produced by the unequal refraction of the light.

Several sections were made—horizontal, vertical, and oblique—with the same result, each showing cells with thick walls, and in a few cells a central nucleus. Viewed with oblique light the membranous coating of the cell was beautifully seen. When compressed between the compressorium or 2 plates of glass a rupture of the cell-wall was effected, and a drop of water or glycerine (glycerine answers best and permits greater refractive power) being placed on the slide the contents of the cell were floated out and appeared to be granules variously shaped. I neglected to test for starch, but doubtless from the analogy of the nut it would be found to be composed principally of that substance.

Having examined the healthy nut thus far, I then proceeded with the curious specimen. The diseased nut was affected with a malady which had consumed it, and it was no longer a very agreeable subject to investigate; but the student of natural history must not sicken at an unpleasant smell nor shrink from a disagreeable sight—such will sometimes afford the best means of instruction. The appearance of the shell was as if it had been soaked in oil, doubtless owing to the oily matter from the cells of the nut being set at liberty. Decomposition had produced heat, thus rendering the oil more liquid and enabling it to permeate the walls of the shell. The kernel was entirely decayed, no trace of cell being visible, nothing remaining but a soft, oily and sugary mass of a dirty yellow color; the epidermis being thinner than in a healthy specimen, but exhibiting the same markings. My first care was to remove a small portion of the dirty yellow matter. This placed under the microscope with a power of 300 diameters there stood revealed a reticulation of thread fibres, beautiful in their confusion. They were interlaced in every direction, a mere mass of fungi, the production, probably, from some errant spore released from its parent stem. There it had hitherto nestled, under the tropical sun of Brazil, until, arriving at a period when it became necessary to procure its own subsistence, it started on its voyage of life and wandered along in the breeze until it found a resting place within this yet unripe nut. Here it grew with its growth and fattened upon its decay. Not a trace of cell was visible; nothing but the threads ramifying in every conceivable direction.

The specimen was treated with various chemical reagents, but in nothing showed the structure more distinctly than when merely mounted dry and covered with thin glass. When viewed with oblique light, only a small pencil of rays being permitted to fall upon the fibres, they were found to be hollow tubes exceedingly delicate in appearance, but in reality very tough and tenacious. Here and there were to be seen small globular bodies of what seemed to be sporidia. One particularly engaged my attention as it rolled gently over the field of the microscope. It was studded with minute points, darker in color than the surrounding mass. Another specimen was examined, not quite so much decayed as the first. The same thread-like fibres were to be seen, but with a different configuration, and crossing the field was a very dark brown string of fibro-vascular tissue. Probably owing to its greater density of structure it was enabled to resist the parasitic fungi which had destroyed so much around it.

Here, then, was a lesson taught by a very simple object, combined with the power of observation. How many would have thrown it aside disgusted with its unpleasant odor, without a thought that, disagreeable as it was, it yet contained within it a mass of vegetable life? The query arose, Was the fungus the cause or the effect of the disease? A wide field for inquiry was opened by this nut. In nature nothing is made in vain; the decay of one plant or animal furnishes food for others, until at length plant, animal, and parasite return to dust, and even in the last act afford means of subsistence to a new race more highly developed.

Reports of Recent Articles.

Food of fresh-water fishes.—Dr. S. H. Forbes, in article vii, vol. ii, of the Bulletins of the Illinois State Laboratory of Natural History, presents the results of observations on this interesting subject, extending back as far as 1876. A table exhibits the number of species examined and the number and names of the prey. Twenty-eight species were examined, and in some cases as many as forty-three individuals of a single species. The table of prey includes tadpoles, numerous fishes, all sorts of invertebrates, and various vegetable food. One specimen of the pike (*Esox lucius*) was found to have in its stomach dragon-fly larvæ 20 per cent., but all the other specimens examined contained only fishes, of which 9 per cent. were not distinguishable, 21 per cent. were sunfish and black bass, 9 per cent. were croppie (*Pomoxys*); gizzard shad and buffalo fish were also found among the prey. The brook pickerel feeds on larger aquatic insect larvæ and small fish (*e. g.*, minnows, m etc.), in about equal proportions. They eat no vegetable food, and see ker forced to their predacious mode of life. The food of the white suc ara, (*Myxostoma macrolepidotum*, Le S.) is chiefly animal, including Vivip About Melantho, Stomatogyrus, and Amnicola, Lymnala, Physa, Planorbis. form one-third is of insect origin, mostly dipterous larvæ. Distillery slop eeders. an important element in the food of these and many other vegetable f prom- The case of the remarkable shovel-fish (*Polyodon spathula*) is given is desti- inence. The fish is of large size (30 lbs., 6 feet long). Its mouth pparatus tute of teeth, and it depends for food on a remarkable straining a sect larvæ borne by the gills. The food is never fish nor mollusks, but in cess to the and crustacea. Its huge mouth and straining apparatus give it ac eserved for immense stores of minute insect and crustacean life usually r because of small fishes. The creature interests the comparative anatomis its retention of many juvenile characters in its adult state.

Causation and prevention of pneumonia.—A pamphlet on the Causation of Pneumonia, by Dr. Henry B. Baker, is being distributed by the Michigan State Board of Health. It is an eighty-five-page pamphlet, and is a compilation of statistics, collected by the State Board of Health, relating to pneumonia in Michigan and in other parts of the world. It is a thorough consideration of the subject, and seems to prove that pneumonia is controlled by temperature and humidity of the air. The pneumonia increases after the atmosphere is cold and dry, and decreases after the air is warm and moist. One would suppose that such climatic causes could not be controlled, but Dr. Baker points out how he thinks the disease may be greatly lessened by controlling the temperature, and especially by moistening all air which requires to be warmed in all buildings, public and private. During the time of greatest danger from the disease (cold weather) most people spend half their time in buildings where such conditions can be controlled, and Dr. Baker claims that it is the long-continued exposure that causes this disease; so that, if the indoor conditions are properly cared for, this disease will be greatly lessened.

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New marine laboratory in Japan.—*Nature* (May 24, 1888) describes and illustrates the new marine station erected by the Imperial University of Japan, under the direction of Prof. Mitzukuri, at Misaki. Misaki is a fishing village, easy of access from Tokio and Yokahoma, and has long been a favorite collecting-ground for naturalists because of the abundance and variety of its fauna and flora. The director of the station, from his instruction in this country at Yale and Johns Hopkins, and later with Balfour and Dohrn, fit him well for the guidance of this important station and engender the hope that important additions to our knowledge of life and its phenomena may be expected thence. The buildings are illustrated in *Nature*. They have the usual outfit necessary for good marine work. Attendance at the station during a certain time will be required of all zoölogical students at the Imperial University.

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Medicine in Michigan.—We have received a copy of the programme of the Sanitary Convention held under the auspices of the State Board of Health at Manistee, on June 5 and 6. Various topics were presented and discussed. Among them, the water supply of the city of Manistee; relations of the press to sanitation; hygiene of bathing; hygiene of schools; restriction of prevention of communicable diseases from the stand-point of the lawyer, clergyman, physician, and State Board of Health. Scientific medicine we are glad to see receives great attention in Michigan, due to the work there, among others, of Dr. V. C. Vaughan. The report of the State laboratory gives signs of great activity in medical research.

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Blood Corpuscles of Cyclostomata.—D'Arcy W. Thompson* corrects the common statement (*e. g.*, Huxley, Vertebrata, p. 100) that the blood of cyclostomes, unlike that of all other fishes, has round corpuscles. In *Myxine* he found large oval corpuscles whose nuclei stain quickly and deeply with magenta. In *Petromyzon marinus* he found them to be circular. In the larval petromyzon the corpuscles are large and oval, and it is a curious fact that those of the adult Myxine resemble in size and shape those of the larval Petromyzon. In the tadpole the corpuscles differ from those of the adult.

* Amer. Mag. N. Hist., ser. 5, vol. xx, page 231, 1887.

EDITORIAL COMMENT.

By HENRY L. OSBORN,
HAMLINE, MINN.

The new **Marine Biological Laboratory** at Wood's Holl, Mass., to which reference was made in the July number, has had a satisfactory attendance for the first season, and promises, from the responses of colleges and students, to be well attended hereafter. It provides a building well adapted to the requirements of either beginners or investigators; microscopes, well-lighted work-tables, boats, nets, dredges, etc., so that one can find all the necessaries for a month or two of summer study.

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The **British Association** met this year at Bath, under the presidency of Sir Frederic Bramwell. Mr. Thystleton Dyer presided over the sub-section of Biology. One subject set for a discussion, to be led by Dr. T. J. Hickson, was coral-reefs, on which much has recently been written in *Nature*. A report was expected by a committee appointed to investigate the effects upon the human body of various mechanical occupations. This report was probably of very great interest, because the committee sought to ascertain the effect of constant uses of various organs and the disuse of other parts by very careful quantitative experiments.

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Meaning of varieties and species.—Prof. H. W. Conn, in a late number of *Science* (May 25, 1888), calls the attention of naturalists to the important question of the definition of species, and in particular to the suggestion of Romanes in his article on Physiological Selection (*Nature*, August, 1886), and claims that the matter has not received the attention which it deserves. The point added by Romanes to Darwin's own theory gives to varieties and species a peculiar significance not hinted at by Darwin himself. It is that 'varieties are forms in which variations of structure have been selected naturally or artificially and propagated by inheritance; and further, that these variations are those of any part of the physical organism, save only the generative system, while species are forms in which modifications of the generative system have been inherited with or without accompanying variations in other organs.' In support of this theory we find that some species differ scarcely any in the more obvious characters of skin-marking, proportion, coloring, etc., and yet are so unlike in their generative systems that the males of one cannot fertilize ova of the other; while varieties of external form and proportion, color, etc., are perfectly fertile when crossed. Cases among birds and insects are numerous and in other groups as well. The suggestion, while it does not assign the cause, gives a valuable hint regarding the direction in which it may be sought. It furnishes a clue to the explanation of the infertility of forms apparently much alike and of the intercrossing of others apparently so unlike. Darwin regarded species as exaggerated varieties. By this hypothesis they are not such, but variations along other lines from varieties. It is quite as supposable that variations should occur in the generative system as in any other, and at the same time it is true that here they would be very inconspicuous.

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Scientific accuracy of statement cannot be demanded from everyone in daily speech, but when one comes before the public should he not be expected to be truthful? It is an offence in most parts of the United States to violate the principles of orthography or syntax, to locate Heidelberg in Brazil, or to consider the Neva a range of mountains; and one of no historical knowledge holds his peace or is rightly put to shame. And yet biological blunders pass

unnoticed and unanswered. We recall the wonder aroused last summer as our astonished eyes rested, in a New York Elevated Railroad station, upon a painting purporting to represent a monster which inhabits the Croton water. This creature is an animal not yet known to science and whose discovery would puzzle every naturalist, for it united the head of a vertebrate with the body of a scorpion and the tail of a class as yet undiscovered.

A company, in disregard of the distinction beween a food and a poison, advertise *Roach Food*. We hardly think that it is necessary to nourish roaches, for, as far as we have observed, they thrive well enough without our assistance. A sign which published a parallel blunder in spelling would appear ridiculous.

Years ago we paid five cents to look into a street-corner microscope and espy the animalcules in a drop of drinking water. In later years we tried hard to duplicate the scene there observed, but invariably found drinking water to be totally free from monsters, and could only match the instance by water from the most putrid source.

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Correspondents will please note that the Editor's address is Hamline, Minn.

NOTES.

University of Minnesota Medical School.—The Board of Regents has established a medical department in connection with the university. The department is located at Minneapolis and is to be a high-grade school, embracing the main features of the medical department of the Northwestern University, Harvard, the University of Michigan, and the University of Pennsylvania. This does not increase the number of Schools in Minnesota, but, upon the contrary, reduces the number. The Minnesota Hospital College and the St. Paul Medical College cease to exist, and several of the faculty of each school are elected to positions in the new school. This action is largely in response to the wishes of the profession of the State. The faculty will be in sympathy with higher medical education, and work in harmony with the new medical practice act. A committee, consisting of the President of the State Medical Society, the President of the State Board of Health, the President of the State Board of Medical Examiners, the President of the University, the Dean of the Medical Department, nominated the faculty for the new department. The committee will secure the best men at their command. Professor C. J. Bell, of the Johns Hopkins University, the only eastern man in the faculty, is elected to the Professorship of Chemistry. The University is very amply endowed in lands by the State, and by maintaining a high curriculum for its medical department it will undoubtedly enlist the good wishes and support of the profession of the Northwest.

Hayden Memorial Geological Fund.—Mrs. Emma W. Hayden has given the Academy of Natural Sciences in Philadelphia $2,500 to provide a bronze medal, and a balance of cash, to be awarded annually to competing naturalists from any country as a prize for the best geological research.

Mounted objects.—Miss M. A. Booth, of Longmeadow, Mass., has sent a list of the objects which she offers for sale at a very low price. We have examined many of her mounts and find them entirely satisfactory. Diatoms from many different localities are offered, also many animal and vegetable preparations. Any who are purchasing slides or material will find it worth while to look through the list.

Annals of Botany.—The first volume of the new botanical serial of this title has recently been completed and must be recognized as taking a rank among the very best. It contains thirty-one original communications, many of them extended articles. These are illustrated by 18 plates, in part colored, and 6 wood-cuts. Besides the publication of original matter the Annals furnish a very complete record of botanical information. One department records the death of botanical students, with a bibliography (by title) of their works. Another records by title the names of all books and pamphlets and all periodical literature classified under the name of the journals in which articles appear.

Life-lore is the alliterative title of a new English magazine of Popular Biology. The August number (No. 2) contains an account of the New Plymouth Laboratory, and articles on Symbiosis, British Rock-boring Mollusks, Introduction to the Study of Dragon-Flies, and Thomas Bewick. It is published monthly at sixpence per number.

S. P. Langley, Secretary of the Smithsonian Institution, has recently published a work called *The New Astronomy*, which receives a very enthusiastic notice from a critic in *Nature*. Some of the topics are familiar, having been previously treated by Prof. Langley in the *Century Magazine*.

Prof. Hitchcock and wife, who have been in Japan for the past two years, have started on the journey homeward. They gave up, in June, their charming bungalow at Osaka which had been their home during their stay, and went to Yokohama. About the first of September Prof. and Mrs. Hitchcock were to sail for home by way of China, India, and Europe. They will spend a short time in China and in India, but will make their longest stop in Germany. They will arrive here in November or December.

Dr. R. Von Lendenfeld has received from the Berlin Academy of Natural Science a grant of 1000 marks to be used in prosecuting studies upon the function of digestion in sponges.

The U. S. Fish Commission has recently succeeded in sending lobsters alive to California, 350 being gotten through alive out of 600 which were started. They were set free in the waters of the Pacific coast near San Francisco.

The Marine Biological Laboratory at Plymouth, England, has been completed. It cost £12,000, has an annual income of £9,000. Prof. Cunningham and Prof. Weldon are in charge of it, and are at work, the one upon the Life History of Food Fishes, the other on the Crustacea of Plymouth Sound.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

OFFERED.—Diatomaceous earth from Thibet, various localities (12,000 feet); also, material and slides of diatoms from Scottish Highlands, and continental foraminiferæ. WANTED.—Slides of American diatoms, insects, or botany. W. D. STEWART, 2 Gilmore Terrace, Edinburgh, Scotland.

OFFERED.—Sections of vegetable ivory and slides of crystalized maple sugar. Good mounts taken in exchange. WM. LIGHTON, 106 Fifth Avenue, Leavenworth, Kansas.

WANTED.—Parasites and books on Parasites and other micro. subjects. Will give Anatomical, Pathological, Botanical, Micro-fungi, Zoophytes, Polycistinæ, Foraminifera, Parasites, and other slides in return. FRED. LEE CARTER, Gosforth, near Newcastle-on-Tyne, England.

Wanted, Diatomaceous earth from Mégillanes, Bolivia, South America. Can give in exchange either Diatomaceous earth from New Zealand or cash. E. MICHALEK, I. Fleischemarkt, No. 1, Vienna, Austria.

Mounted sections of Fœtal Lung (5 months), sections across entire lobe, $\frac{1}{200}$ in. thick, beautifully stained, in exchange for first-class pathological slides. W. C. BORDEN, M. D., U. S. A., Fort Douglas, Utah.

Wanted, earths, recent diatoms, and miscellaneous objects for mounting. Only first-class material offered or desired. MARY A. BOOTH, Longmeadow, Mass.

Fossil Diatomaceous deposits (marine) wanted from Bermuda, Virginia, Maryland, California, etc. I. ELLIOTT, Ardwyn Villa, Aberystwith, Wales, England.

Labels for slides. EUGENE PINCKNEY, Dixon, Ill.

Correspondence relative to exchange in microscopical material or prepared mounts. HENRY L. OSBORN, Hamline, Minn.

First-class Histological Slides for other good mounts; Histological and Pathological material cut on shares. S. G. SHANKS, M. D., 547 Clinton Ave., Albany, N. Y.

FOR EXCHANGE.—Strichnia Chromate (Strichnia $\frac{3}{50}$ gr.) and Strichnia Ferri-Cyanide (Strichnia $\frac{1}{100}$ gr.) Will exchange for other slides, Botanical preferred. Only first-class slides offered or desired. L. A. HARDING, Fergus Falls, Minn.

Notices.—All communications for publication should be addressed to Henry Leslie Osborn, Hamline University, Hamline, Minn.

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Elementary Histological Studies of the Cray-fish.—XI.

BY HENRY LESLIE OSBORN.

CHAPTER IV.—THE OVARY.

III. Histology.—(Continued from page 143.)

2. *Examination of fresh material.*—If one would be thorough in the study of the ovary he must not trust alone to sections, though from these he can learn a great deal with regard to the structure of the organ under discussion. To mount fresh material for study first break into two pieces a $\frac{1}{2}$ in. cover-glass and lay the two halves on the centre of the slide, leaving between them a small oblong compartment. This will form a cell and support the cover from resting heavily upon the object—a fatal mishap should it occur. This simple cell will further be open at each end for the very ready passage of fluids if you wish to irrigate. After the cell is thus ready for use, snip with fine sharp scissors a bit from the ovary containing a half dozen eggs,* and spread it out carefully in the cell, put a drop of salt solution (see page 141 foot note) upon it, and then carefully lower the cover over it. If the cover presses upon the eggs, which may be thicker than thin glass, build up the cell with halves of a second cover-glass. With the naked eye can be seen on the mounted specimen the yellow color of the eggs, and in the centre of each egg a minute, lighter-colored spot. The low power will show that there are on the slide, besides the eggs with the yellow contents, numerous round or oval bodies of small size, uncolored, and with a central, transparent spot in each. With the high power, examine in more detail all the parts of the slide.

N. B.—In studies of live eggs or of any mounts of fresh material it is best to use the microscope with the stage horizontal, because of the change of field in a fluid due to gravitation in a stage inclined. The slide contains two substances to be examined, viz., the ripe eggs and the young eggs.

1. *The ripe egg.*—This is very opaque. On its border, when the lens is leveled for the focal plane passing horizontally through the centre of the egg, a thin translucent belt can be seen encircling the egg. Study of this shows it to be cellular, for nuclei can be demonstrated in it. Selecting an egg in which the envelope is slightly separated from the egg proper, use it for further observation. First irrigate with dilute acetic acid (.5%), being very careful not to use the acid too strong nor for too long a time. Then focus up slightly above the median level of the egg and you can obtain surface views of the envelope slightly oblique; and here the acid will demonstrate beautifully the pavement epithelium of which the egg envelope is

*I have spoken thus far, and shall continue to so speak, of the products of the ovary as eggs; this term is a convenient one to use. It must be understood that, strictly speaking, these bodies are called ovarian-eggs, and that they are not as yet ready for development.

formed. This envelope is the follicle from one of the cells of which the egg was originally formed, and by the cells of which it has been nourished and built up. Very pretty pictures of the very regular follicle epithelium can be formed by killing the egg with its follicle in alcohol instead of in acetic acid, as before, and then treating the preparation on the slide with hæmatoxylin or one of the carmine stains. These could be permanently preserved in glycerine jelly, or, after proper treatment, in balsam. They help out the observation of the section in regard to the structure of the follicle epithelium. The egg within is so opaque that but little can be seen of its structure in this way, and we must rely upon sections for additional information respecting it. If we crush one of these eggs we can see that the yellow yolk is made up of numerous small droplets, and that the spot in the centre is a clear body with an extremely fine line limiting it. The spot in the centre is the *germinal vesicle* or nucleus, and the egg is really a cell, though one very unlike the cells we have met thus far.

2. *The young eggs.*—The smaller bodies found in the angles between the large eggs, and named the young eggs, are at first sight very unlike the eggs. They are not only smaller in size, but very variable, most being perfectly transparent while still alive, but some of the largest are yellowish and opaque. Young eggs are the source of the eggs just described, and they grow from extremely minute bodies hardly at all egg-like. The young egg, unlike the mature one, is of all varieties of shape, for it seems to be obliged to take on any shape the space between the large eggs permits. It is not often round, but usually oval or flattened. Each one is seen to have a thin follicle around it, the pavement epithelium of which can be demonstrated, but not quite so clearly as in older eggs, because the egg fills the follicle more compactly. The egg itself consists of a translucent, faintly granular body and a central, very clear nucleus or vesicle. The body is colorless and gives no evidence of the presence within it of the yolk substance. It is composed of nearly unmodified protoplasm, and the youngest eggs are hardly different from the kinds of cells already met, except in shape and mode of attachment. The nucleus is large, has a very sharp, thin line bounding it, and is very transparent in a perfectly fresh egg. The nucleus contains, besides the transparent substance, a number of minute droplets which always lie close to its margin. In an egg which has stood long enough for the protoplasm of the nucleus to die, the nucleus is found to be not empty, but to contain matter, then seen as granular, which is scattered through it in such a way as to leave many clear spaces. The epithelium of the follicles becomes much clearer in the dead eggs. It is possible to bring out these facts by killing the cells with alcohol by irrigation, when the protoplasm coagulates and becomes visible.

Besides the eggs with their coverings, the latter being in truth the ovary, while the former are but its products, there is still the whitish substance which, as you remove the eggs, you will see forming a sort of ground substance in which the eggs are held. If you wish to examine it further you should first cover a bit of it for a moment with alcohol, then for a few minutes more with borax-carmine, then wash this out with acidulated alcohol. Then cover the specimen and examine it in alcohol. All this can be done in a few minutes, by treating the specimen on a slide from the start. It will demonstrate the cellular character of this whitish substance. Many long narrow cells are found, possibly muscular, but more careful treatment would be required to determine more than that the substance was an important tissue of the ovary.

IV. General conclusions.—Having examined both preserved and fresh preparations of the ovary of the cray-fish, we are now in a position to form some conclusions upon the organ and its physiology or mode of action.

The purpose of the ovary as an organ is to produce eggs. If we were to state in abstract language the structure of the ovary it would be framed thus:—the ovary is an organ composed of numerous sacks or follicles communicating with a common outlet, the oviduct. The recesses or follicles are shut off from direct communication with the blood spaces of the body by a flat-celled epithelium. Within each follicle there lies one large body, an egg. In most respects this description of the ovary would be equally true of the green gland, or of the liver.

Unlike them, however, we have the cavity of the follicle not occupied by a secretion, but by a nucleated body possessing many of the peculiarities of a cell. The shape of the follicular epithelium-cells would not interfere with one regarding the ovary as a gland, for variety in shape can be found in the cells of any gland. The egg, however, is at first sight entirely unlike anything found in glands like the green gland or the liver, and we must consider it more carefully. If a very young cray-fish were examined, that ovary would be found to be very unlike its form in the adult. Instead of numerous follicles a simple skin would be found of epithelium cells forming a chamber and opening to the outside by a tube. The wall of this chamber, as the cray-fish advances toward maturity, becomes covered with small, pimple-like sacks, these sacks being the beginnings of the future follicles. These sacks are at first empty, their walls being composed of cells of what is known as germinal epithelium.

One cell of the germinal epithelium, apparently exactly like all the others of the follicle, breaks away from the wall of the follicle and takes a position in the cavity of the follicle, and the wall closes up the space where it stood. The cell which has thus been pushed into the cavity of the follicle is at first like the others from among which it came. It is small, with the characteristic nucleus, protoplasm, and outer wall; but globular, because free from contact on all sides. This cell is the future egg. Why any particular cell is the one to become the future egg rather than another, and whether any cell could have been so distinguished of all the cells of the follicles, no one has thus far been able to positively say, though many have attempted to find an answer. The most careful study of the ovary has not settled this problem; doubtless, when it is settled, it will help to bring within our reach the answers to many questions now floating about in a very nebular manner.

When the egg has thus become differentiated from the germinal epithelium or begun a recognizable existence, we can follow it as it at first enlarges in size by the increase in its protoplasm, then later by the addition of deutoplasm, the follicle also growing larger to accommodate it. We can now see a stronger reason for regarding the egg as a cell. We find grounds from the study of its anatomy merely, but stronger ones from a consideration of its history. The egg can be traced backward from its mature condition to the form of a simple cell of germinal epithelium. When it has been fertilized by the spermatic fluid of the male it goes forward towards the production of a new cray-fish with its multitude of cells with multifarious uses. What a mystery that this single cell should be capable of begetting so complete a creature as a cray-fish.

But the inquiry comes up as we observe this history of the egg and of the follicle, whence comes the protoplasm and the deuteroplasm which go into the young egg in the follicle so that it can become a mature egg? Here we learn the uses of the follicle epithelium. It is partly to protect the egg, but its far more important purpose is to pick food out of the blood and pass it through to the egg. Not only are the follicles of less dignity than the egg, in that they are not to have the distinction of perpetuity as is the egg, but they are further made to labor for it by ensuring to the egg that only the de-

sirable substances of the blood shall escape from it to the egg. Here we see the follicle cells performing glandular work, for no true definition of a gland can be framed which does not contain the physiological idea of the organ as active in transferring substances from the blood to its cavity. We have, then, clearly outlined before us the use of the follicle in producing eggs, in nourishing them until they are built into the proper product for fertilization and the initiation of a new course of development and the production of a new generation.

Turning to the egg itself, we may briefly attempt to learn the uses of its parts. The parts are the nucleus, the protoplasm, the deuteroplasm, and the cell-wall. But when we see that the egg-cell with only a very slight amount of additional substance of the spermatozoon is capable of such a wonderful performance as the production of a cray-fish without any help from outside, it being only requisite that the egg be kept in pure water and allowed air and warmth, we must at once infer that the inside of the egg is not so simple as intimated by seeing only the protoplasm, the nucleus, and the deuteroplasm. If fact, it seems likely that *no physical organism exists which exhibits anything comparable in complexity with the physical mechanism of an egg* when it starts on its career of development.

It is not proposed here to assert or to deny anything whatever regarding a possible psychic factor which may or may not be present with the physical mechanism which is present in the egg. The psychology of the cray-fish egg is certainly reached at this point, but it is not the purpose of the present series of articles to discuss it. Finally, then, what is the work performed by the nucleus protoplasm and deuteroplasm? No answer in detail as to the work done by each can be given. In the first place no one fully understands the structure of these parts. One answer, however, is found which is practically agreed upon by all students of the subject and which is reached by a study of the destination of parts and of their behavior while at work. It is plain to all that the material substance of the growing egg is derived from some recognizable source. It is equally certain that this source is not the water outside the egg. Hence it is necessarily within the egg itself. It is also well known that no protoplasm, and much less any other substance, has the power of directing chemical composition so as to produce the substance, of which protoplasm is formed, except from a limited range of highly organized albuminous substances. Since the actual amount of protoplasm is constantly increasing and must have a source, we should look for it in the deuteroplasm. We find this constantly decreasing in amount, and we further find it actually in process of digestion in eggs as soon as the digestive epithelium has arisen. Without entering into all the proofs for the position, it may be stated as fully believed as if a matter of fact in embryology that the purpose of the food-yolk is to furnish material to build up cells before the time when the embryo will commence foraging for this material. The work of the protoplasm and of the nucleus is not so certainly known as is the use of the deuteroplasm; yet, there is practically a united assent at present to the assertion that the nucleus has to do with the reproductive function, and with the production of new cells, while the protoplasm has to do with the activity of the cell on its own personal account, so to speak. The behavior of nuclei everywhere seems to show that their work consists in the production of two or more cells from one, while the work of the cell-protoplasm is to build up each of the two cells into the mature cell-condition. Thus let us imagine a vorticella a full-grown animal. It sometimes grows by the division of its nucleus into two parts, followed by division of the body; thus two small vorticellæ arise. Their next act is to grow to full size, and this appears to be by aid of the protoplasm. Besides producing the growth the protoplasm is believed to be further con-

cerned in the activities of the cell in daily life. Thus, of a ciliated-muscle cell, the protoplasm would seem to free the energy used in the motions, and to restore during rest the protoplasm broken down in work, while the nucleus is concerned in the production of two ciliated cells from one, and the protoplasm later is concerned in the growth of the two ciliated cells from the former one.

It is to be observed that while this answer assigns to each part of the cell some occupation, and one which fits well with the facts, it is only superficial. It by no means satisfies our questions, for it does not in any sense tell us just how or what any one of the parts does. To say that the nucleus presides over reproduction only states its sphere of activity without in the least telling *what* it does. The cytologists are all trying in every way to find out the structure preliminary to finding out the use of every part of the cell, but at present they have not reached conclusions which have won universal consent. It is due to the great industry and patience of their difficult researches to say that indications of success in part, at least, are very good, and that the past progress of biology leads us to expect that these facts will also be obtained.

Protococcus—An elementary study in biology.

By HENRY L. OSBORN.

In the examination of yeast not long since we were studying one of the lowest and simplest members of the plant world. In the specimen now before us we have another of the lowest plants. The plant *Protococcus viridis* grows almost everywhere and there is no one who cannot find material at this season of the year. The plant forms a vivid green incrustation upon stones and wood, but is most profitably sought growing upon the trunks of trees or on the hemlock boards of fences. Since there are numerous green incrustations growing in such situations, some further description of the naked-eye appearance will be helpful. Protococcus forms a very fine-grained, almost powdery, looking growth wherever it is found, and the green is darkish. One plant much higher in organization than Protococcus, growing in much the same way, is the lichen of various form, but usually of a duller grayish green and often flaky or leafy in structure, not a fine powdery dust.

Another kind of plant common in damp places, on boards and stones, is, on close examination, found to be composed of a sort of felt of fine threads. It is an Alga not at all like in shape to Protococcus. It is quite likely that in the search for Protococcus one or both of the above may be found first. Protococcus is more commonly found upon the north side of the board or tree trunk because so well shaded. It may grow on the south side if well shaded. To find it one should hunt for an unpainted hemlock fence, or for a tree whose trunk is well covered with a fine green coat. With a knife cut off a few small pieces of wood or bark bearing the green growth and wrap them in a piece of paper. They may be allowed to dry up without injuring them. When ready to study them, it is well to place them in a damp atmosphere for some little time (24 hours) before the examination, though this is not absolutely essential. Of course one who was uncertain as to his material would do well to collect samples of all the various green incrustaceous growths he could find.

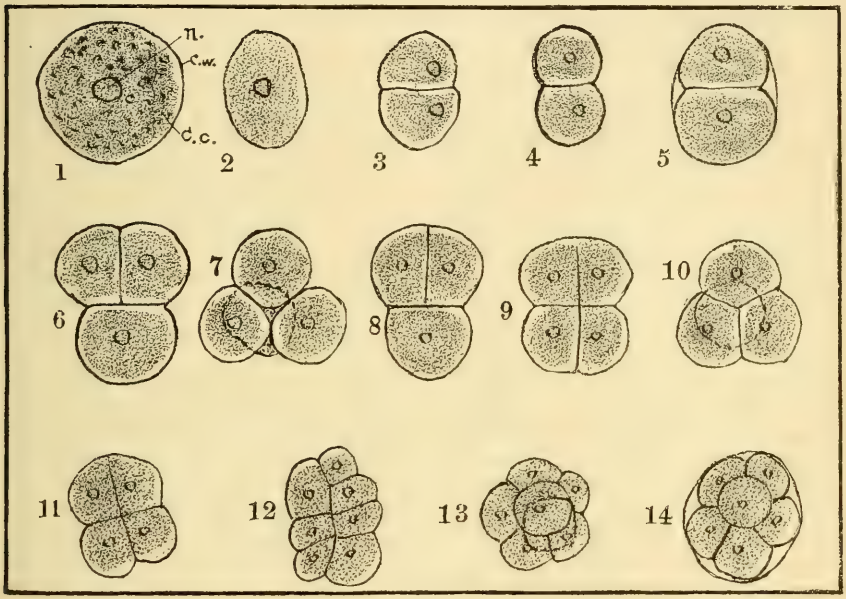
In studying Protococcus the very simple apparatus required are microscope, watch-glasses, slides and covers, dropping tube and water, blotting-paper and needles. With a needle scrape a very little of the green coating from the bark upon the centre of a glass slide, taking care to remove only the green coat and not to dig below it into the bark itself. When a little of the

green has been caught on the slide scrape it into a heap in the centre, place a drop of water on it, then gently cover it with a circle. Examination with low power (50 diameters) will not show much beyond a heap of minute, greenish grains, and the high power (300 diameters) must be used at once. It will show that the fine powder is made up of fine grains, some of which are collected into masses and several others independent. It is better before attempting to unravel the facts from the tangle of plants before one to separate as well as possible the mass. This might have been done by teasing before the cover had been put on, but can be better done by tapping the cover-glass. To do this take the teasing needle and, holding it vertically over the cover, hit it firmly and forcibly several times just above the heap. This will soon spread out, and a continuation of the tapping will effect far more than teasing could in this instance. To make the tapping successful mount the specimen carefully thus:—drop on, before covering, less water than enough to fill out the space beneath the cover, and then add from the dropping tube enough to just fill out this space. The tapping will, perhaps, destroy a few of the plants, but it will for the most part only spread out those which would otherwise produce indistinguishable confusion. In case the first slide prepared is not successful, do not hesitate to try it again and again, thoughtfully profiting by failures. There is no royal road to learning this; it is a matter of hand-training, and with repetition is bound to come.

The slide, when prepared properly, will show a great variety of little globules compounded in many ways, besides several other matters not belonging to the plant. It is easy to rule out as not belonging to the study all bodies not bounded by spherical walls and containing green matter. All the spherical bodies with green are Protococcus. You must at once try to neglect everything else in the field and concentrate your attention on the plant. To do this is not so easy at first, and it will seem, perhaps, as interesting and curious to examine numerous other things which may be in sight. A glance at Protococcus will show that it is made up of bodies which are bounded by curved lines of black or white, according to the manner of focusing. A great variety is now found—here single circles, there several, three or four or more loosely adhering; again, ovals and ovals with indented sides and a line across them. Selecting one of the circles, examine it first. The sharp line which bounds the mass within can be seen. Perhaps just within this line there is a light space. These two appearances may be reversed by focusing, and are due partly to behavior of the light as its course is modified by the boundary line of the plant. Within this boundary line may be seen a green substance pervading the entire body. This, on more careful study, is found to be not homogeneous even in texture, but is broken up into lighter and darker spots. This appearance is designated granular. In the centre of the granular substance there can usually be seen a green body of homogeneous appearance. Careful study is required to bring this central body into view. The parts thus seen are the outer boundary, called the cell-wall (Fig. 1, *c. w.*), the green substance, called the cell-contents (Fig. 1, *c. c.*), and the central nucleus (Fig. 1, *n.*) These are the necessary parts of a Protococcus plant, and this single body is a complete plant, capable of anything which it is possible for Protococcus to perform. It is necessary to call the especial attention of beginners to one question at this point, viz., the shape of the little body he is studying. It must be remembered that the microscope deals only with surfaces, and that it may require a number of views to tell the truth as to the real shape of a body. Protococcus, so far as revealed by the appearance of figure 1, might be either a disk or the central plane of a sphere. To the microscopic vision things out of the focal plane are utterly invisible, and an opaque body not large enough to entirely cover the object-glass can be

placed between it and the object and nevertheless be entirely invisible. But focusing up and down shows the different levels and proves the spherical character of Protococcus. A single sphere of Protococcus is a cell. It has all the characteristics of a cell.

It is necessary to say one word regarding a point which cannot be easily proven for Protococcus. It is regarding the nature of the cell-contents. It is believed, with every reason for confidence, that this substance is composed of two distinct parts—one made up of very minute drops scattered through the mass which makes up the cell-content. This contains the substance which gives the green color to the plant, and is *chlorophyl*. The remaining substance is protoplasm. This furnishes the reader with a very brief sketch of the facts regarding the structure of the plant in one form, most of which he can easily verify for himself.



A second set of facts comes out when we notice the modes in which the cells of Protococcus are aggregated. It is the most noticeable thing at first that the plant-cells are in groups of two, four, or more. Examine first several different groups of two each. Hardly any two are exactly alike. Fig. 3 shows a group of quite common form where there is a very faint indication of constriction, while Fig. 4 shows a very deep constriction between the two cells. In Fig. 5 we find still another case with a deep constriction within, but with a boundary line or cell-wall not constricted outside. Examination of each cell in these groups shows them to contain granular chlorophyl-bearing contents and a nucleus. Further study brings to light groups of three or four or more cells. These are called cell-families. Fig. 6 shows a group of three, one large and two small ones. Fig. 7, taken from what seemed at first to be a group of three, proved, on more careful study, to be a group of four. Fig. 8 shows a group of two, with a resemblance to the group of three in Fig. 6. Fig. 9 represents a group of four, all in the same plane; Fig. 10, a group of three in the same plane, but with a fourth in the plane below—really a group of four. Fig. 11 is a group of four, but in two sets of twos, and with one

set more distinct than the other. Fig. 12 represents a group of seven; Fig. 13 also a group of seven, but not all in the same plane as was the case in Fig. 12. Fig. 14 represents a group of seven, but unlike Fig. 13 in that the entire group is surrounded by a cell-wall as was the case in Fig. 5.

A number of different forms have been purposely drawn; many others could be found and would show either modifications of the forms already detailed, or perhaps some new departures. In many cases more than seven cells could be found. Now is there any deeper fact indicated by these groupings? They are every one of them in accord with the law which governs the mode of multiplication in this plant. In yeast it is found that multiplication takes place by budding. A small pimple at one place increases in size until it rivals the size of the cell from which it grew. In Protococcus, growth takes place by *division*. First the spherical cell acquires an oval shape. Then the nucleus divides and the content forms into two parts. A new cell-wall forms across the oval. Later, the old cell-wall indents; this forms a constriction which grows deeper and deeper, as in Fig. 2 and Fig. 3. While this constriction grows deeper, the two-cell contents each undergo a second process of division and begin the formation of four cells out of two. This may take place in one cell first and give a three-celled group (*e. g.*, Fig. 6–Fig. 8), or it may take place in both at once (Figures 7, 9, 10, 11). The older the cells the deeper the constriction; thus, Fig. 7 is older than Fig. 10; in Fig. 7 the cells are nearly cut apart. The divisional planes may keep on in the same plane and form groups like Fig. 12, or they may fall in different directions and produce groups like Fig. 13. This law of division can be traced out from the study of cells in different stages of division. There is a second mode of division inside the original cell-wall called internal cell division, of which two stages are seen in Fig. 5 and Fig. 14. It is much less common than the other mode.

A complete survey of the Protococcus plant would require a look at its physiology. This we can only do very hastily. If some Protococcus were put in pure rain-water it would grow and thrive there, provided it was kept in the sunlight. If kept in the dark it would die. Yeast would live in the dark, but not in pure rain-water. Protococcus has by virtue of the green coloring matter a peculiar power. It can so direct the energy, which is sunlight, that the working part of the plant—the protoplasm—can use it to manufacture its own food from the gases of the air and from pure rain-water. This power does not belong to animals which depend for their food upon plants containing chlorophyl. We can see with the microscope enough to surprise and delight us in the mere green dust on the bark of the tree; but if we could follow the work which is being done inside that minute cell while we are looking at it (if we are working by daylight), how much more would there be to see! We have by no means reached the end—only the beginning. We could with reagents penetrate a little farther and demonstrate the chemical nature of cell-wall and cell-contents, but no one has yet had a peep into the laboratory where sugar and albumen are compounded from insubstantial ammonia, hydrogen, carbon-dioxyd, and water.

Maceration fluid for molluscan nerve tissue is made, according to Bela Haller, as follows:—5 parts acetic acid, 5 parts glycerin, 20 parts distilled water. Specimens, after soaking in this for 4–24 hours, are then teased in 50% glycerin, or washed and stained in picro-carmine or ammonia carmine.

The 10th Annual Meeting of the American Society of Microscopists.

By CHAS. W. SMILEY,
WASHINGTON, D. C.

The Society assembled at Wirthwein Hall, Columbus, Ohio, Tuesday, August 21, at 10 A. M., and held morning, afternoon and evening sessions. On Wednesday morning and afternoon sessions were held. On Thursday there were three sessions. On Friday there was a morning session in Columbus, and an evening session in Newark, Ohio, making ten sessions in all. The headquarters were at the Park Hotel, which furnished reduced rates to members.

TUESDAY MORNING.

On account of the meeting of the American Association for the Advancement of Sciences, at Cleveland, being still in session, the attendance was not so large as had been anticipated. The meeting at Cleveland adjourned late Tuesday evening.

On assembling Professor David S. Kellicott, the president, announced that Professor T. J. Burrill, secretary, was temporarily ill, and suggested that Treasurer S. M. Mosgrove, M. D., of Urbana, act in that capacity. Dr. Mosgrove assumed the office, and among other recommendations suggested that members who were three years in arrears for dues be dropped from the rolls.

The following new members were elected:—J. Edward Bering, James B. Shearer, William Libby, jr., Willis R. Whitney, Charles E. Jameson, Dr. Thomas O. Hoover, Leonard Pearson, Edward P. Lawton and Miss Vida A. Latham.

The first paper was by Professor H. J. Detmers, of the Ohio State University, on 'What I saw in the optical establishments of Germany.' Professor Detmers had arrived from Germany within a few days and the subject was fresh in his mind. He is decidedly of opinion that American appliances are superior to those of the Germans, and states that most of the improvements in German instruments are of American invention. The paper was discussed by several gentlemen, among others Professor Seaman of Washington, D. C., who did not fully agree with Professor Detmers.

The following abstract of his paper is compiled from the St. Louis *Druggist*:—

The doctor, who is a German by birth and education, gave a most interesting account of his visits to the great optical works of Zeiss in Jena, Seibert, Wetzlar, and others. In each he spent a day, devoting a large portion of the time to 'fighting objectives' with the most expert manipulators. He carried with him a one-tenth homogeneous immersion of Herbert Spencer, a one-twelfth homogeneous immersion of Bausch & Lomb, a fifteenth of Tolles, and a few other high grade objectives of American manufacture. He carried, as a test-plate, a slide of *Amphipleura pellucida*, from Lake Nepissing, N. Y., mounted in balsam, boldly stating his belief that the best American objectives in the hands of experts were in every respect the equal of those of the best German opticians, when handled by experts. He challenged to a trial of skill the makers of what the world has acknowledged to be the best objectives—the renowned Apochromatic of Zeiss, and of the other makers above-mentioned. The challenge was accepted, and Dr. Carl Zeiss, being ill, deputed his brother, Dr. Roderick Zeiss, to manipulate his objectives. Every appliance that could assist in the resolution of the diatom was there and brought into play. After striving for some time he yielded, and Dr. Detmers, with his American stand and objectives, readily showed the lines of resolution. Failing in the test of vision, they proposed photography

as the only true test of what objectives should do. The result was the same, with a perfect outfit in the way of apparatus, a special and very costly camera, a heliostat of marvelous accuracy and great cost. A photograph of the *Amphipleura* was obtained, but so full of interference and diffraction lines that the straight and clean lines looked as though they were rows of square dots. Dr. Detmers photographed the object with his little home-made camera box and a coal-oil lamp. He obtained a negative absolutely free from a line of diffraction, each marking line of the diatom standing as sharp and clear as a round in a ladder. The experiences at Jena were repeated at Wetzlar.

As to cost, Dr. Detmers showed by catalogues and price-lists that when grade and quality are taken into consideration the difference is very little. Indeed, in the highest grades, such as he was testing, the American objectives are the cheapest. Concerning stands, the doctor stated that the Germans have of late somewhat improved upon their older models, but in every instance where this has been done the improvement is of American origin. The Germans still cling, says Dr. Detmers, to their squatty models, with a stage so low and awkward that there is no room either above or below it for the accessories which make our American stands the most convenient in the world. To obviate these defects, the Germans make and supply a number of ingenious, beautiful, and costly accessories, each piece of which is intended to correct some one or another trouble caused by defective construction in the first place.

These views of a thoroughly competent German are identical with those held by Americans who have had opportunities for similarly comparing the objectives of the best American makers with those from the most famous of European opticians.

The co-operation of scientists in experiments in a certain line, as suggested by Miss Vida A. Latham of Ann Arbor, brought on a discussion, in the course of which the propriety of publishing an American magazine similar to the one issued by the Royal Microscopical Society of London was urged. Professor Detmers's motion that a committee of three be appointed to consider the question was referred to the executive committee.

Professors Seaman, Kellicott, and Bleile were among those who took part in the discussions.

The press of Columbus, especially the *State Journal* and *The Press*, ably reported the proceedings, the latter introducing its reports with the following appreciative comments:—

'The sessions presented some rare scientific food, to be digested by the students of the lowest orders of animal life. The American Microscopical Association was born ten years ago at Indianapolis, and to-day has a select membership of more than three hundred scientists throughout America. These gentlemen, by the use of the microscope according to well-founded principles, are making rapid strides towards the discovery of the nature and cause of disease. They have discovered a specific germ or organism for typhoid fever, another germ creates tuberculosis, or consumption as it is commonly called, and many other germs producing each its own special disease have been discovered and are known by their size and shape as seen under the microscope. These gentlemen by their scientific investigations know just as certainly that certain germs produce certain diseases, as we do that water quenches fire. These germs under certain conditions of the atmosphere are cultivated. The American Microscopical Association and the Microscopical Society of Ohio are thus developing facts which aid the physician in the practice of medicine. The causes of certain diseases being more certainly traced to their fountain head, the treatment by which patients are relieved of great pain is made comparatively more simple. This association of micros-

copists is one of the most valuable scientific organizations which exists, and is one in which every family is interested, and every man, woman, and child should by all means attend its sessions.

'The investigations which science brings forth put quackery in the shade and will soon relegate unscientific practice of medicine to the realms of the past. Every disciple of Æsculapius should become a master of microscopy, and should be an active member of the American and State Associations.'

TUESDAY AFTERNOON.

At the opening of the afternoon session Professor T. B. Stowell of Cortland, N. Y., read a paper on the 'Histology of the Soft Palate of the Cat,' after which Professor Detmers introduced State Food and Dairy Commissioner Derthick, who recited his investigations in regard to cheese alleged to be poisoned.

C. C. Mellor of Pittsburg exhibited a microscope said to have been brought to this country in 1804 by the Economists, a society devoted to celibacy. This interesting object is supposed to have been manufactured as early as 1740. The society then adjourned to an adjoining room, where Dr. L. D. McIntosh explained the workings of an attachment for projecting or photographing microscopic objects.

TUESDAY EVENING.

The exercises were somewhat social in their nature. Professor Detmers, of the State Society, a vice-president of the American Society, presided, and introduced Mr. Fred. Krumm, who rendered a bass solo with fine effect. He has a magnificent voice.

Governor Foraker, who had been expected to deliver an address of welcome in behalf of the State, was unable to be present.

Mayor Philip H. Bruck delivered a very graceful and at the same time cordial address of welcome, alluding to the fact that nothing in his office was so pleasant to him as the privilege of welcoming strangers to our hospitality, among whom had been of late the State Pharmaceutical Association, the State Medical Society, and others. He insisted that the society believe that what he lacked in language must not detract from the welcome which he meant. The members came, he said, hundreds of miles for the purpose of pursuing their researches and they are welcome. He then spoke of the usefulness of the microscope in the discovery of disease germs, as well as in the detection of foreign substances in food products and in other fields, especially its application to animated nature. The society, he said, deserved the thanks of humanity, and he closed by once more extending a hearty welcome which even the microscope could not magnify.

Professor Kellicott responded as follows:—

'In behalf of the society I most heartily thank you for these kind and generous words of welcome. The words of our response may be few, but our gratefulness is not thus limited. There is a depth and sincerity in an Ohioan's welcome that gives us assurance and makes us feel at ease from the first. Indeed, we are not strangers to this great State, the home or birthplace of so many statesmen, soldiers, scientists, and educators. If I am correctly informed this is a State that fosters education and science in an extraordinary way. I have never believed that there was a university at every cross-roads, with few exceptions, still there are doubtless a great many. I have heard those who should know better speak lightly or derisively of this peculiarity of Ohio. It seems they have not connected this condition as they should have done with this fact, that if every nation under Heaven wanted generals for their armies and statesmen for their rulers Ohio would have eligible candidates and enough left over to care for the commonwealth.

'We have been most cordially received in this beautiful and capital university city, and, moreover, we see on every hand the most admirable arrangements for our comfort and the convenience of our work. We have gathered here from all quarters of the land full of enthusiasm and burdened with facts to be laid before one another, discussed, and tested. Our first purpose is mutual benefit and the progress of science; second, to enjoy a reunion with kindred spirits, joined by devotion to the king of optical instruments of investigation. Therefore you may expect us not to be backward in taking advantage of the privileges you have so fully offered. By the way, scientific men are reputed to be modest and retiring; they have doubtless earned the distinction; still, for one, I have never noticed any marked diffidence when inducements were held out to them. I therefore predict that for the few days they remain here, these, my comrades, will be found to act entirely at home, as true Ohioans, devoted to the affairs in hand, and thoroughly enjoying themselves; and may it prove true that some pleasure and benefit result to you all who have taken so much pains to entertain us.

'I take this opportunity to say that it is the wish of all members of the society that all who are interested in our work shall attend the sessions and take part with us as opportunities are presented.'

After Professor Kellicott's response, Professor Detmers announced a zither duet by Mrs. Professor Weber and Miss Blesch, daughter of Dr. P. E. Blesch. The ladies were loudly encored, and responded.

Dr. Kellicott then proceeded with his annual address, which was the leading feature of the evening session. His paper was a valuable one, both in a literary and a scientific point of view. A vote of thanks was tendered him for the valuable contribution.

Among the prominent microscopists present were D. S. Kellicott, Buffalo, N. Y.; Dr. S. M. Mosgrove, Urbana, O.; Professor T. B. Stowell, Cortland, N. Y.; Dr. W. J. Lewis, Hartford, Conn.; Dr. F. L. James, St. Louis, Mo.; Dr. Thomas Taylor, Washington, D. C.; Dr. W. H. Seaman, Washington, D. C.; Miss M. A. Booth, Longmeadow, Mass.; Miss V. A. Latham, Ann Arbor; Professor H. J. Detmers, Dr. A. M. Bleile, Dr. Thomas C. Hoover and Professor A. H. Tuttle, of Columbus.

WEDNESDAY MORNING.

President Kellicott appointed Professors H. J. Detmers, H. A. Weber and T. J. Burrill as a committee on adulterations of food and diseased meats. The committee will be aided in its investigations by the Ohio state dairy and food commissioner, who will furnish material, and the committee will report at the next annual meeting.

The regular order was then taken up, Professor Stowell of New York reading a paper on 'The Form and Size of the Red Blood Corpuscles of the Larva of the Lamprey Eel, of Cayuga Lake, N. Y.,' by Professor Simon H. Gage, of Cornell University.

The second paper was a 'Partial list of the Rotifera of Thiawasser River, at Corunna, Michigan,' by Professor D. S. Kellicott, Buffalo, N. Y.

He reported the discovery of several new species; in all sixty specimens have been studied.

The next paper was entitled 'Method of Preparing Limpid and Colorless Copal Solution,' by Dr. Frank L. James, St. Louis.

Professor W. H. Seaman of Washington, D. C., read a paper on 'Dry Mounts,' which was illustrated by small brass cells to be cemented to the slides, with brass covers to make them dry and protect them. This does away with the moisture on the underside of the glass and preserves the specimen dry.

The paper of J. M. Steadman of Cornell University on the 'Development and Reproduction of the Sun Animalcule,' was read by C. C. Mellor of Pittsburg. Dr. A. M. Bleile read a paper on 'The Bacillus of Leprosy,' by Chevalier Q. Jackson, M. D., of Pittsburg, Pa. The latter paper was accompanied by photographs of drawings, and recited several experiments made on rabbits.

The morning session closed with a paper by Dr. G. E. Fell of Buffalo, N. Y., entitled, 'Examination of Legal Documents with the Microscope," discoursing on the detection of fraud in legal documents by means of the microscope.

WEDNESDAY AFTERNOON.

In the afternoon the society took cars at the Park hotel for the State University, where they were entertained by Professors Detmers, Thomas, Weber and others in the physical laboratory.

The following papers were presented:—

'Photomicrography with High Powers and Lamp-light, with Exhibits of Photo-Lantern Slides with Electric Light,' by Dr. H. J. Detmers, of Columbus, Ohio.

'Projection of Colored Photographs of Crystals of Butter and other Animal Fats,' by Dr. Thomas Taylor, Washington, D. C.

The lantern slides of the crystals of butter, and the fats used in its sophistication, adulteration and counterfeiting from the photomicrographs by Dr. Taylor, were colored, in the most exquisite manner, to represent the appearance of the crystals under polarized light. Each slide was so faithful to nature that it was very difficult to make those who had not had the pleasure of examining the slides believe that the projections were not polariscopic. It has been but a few years since the idea of using the microscopic and polariscopic appearances of the crystals of the different fats as tests of their purity were first presented by Dr. Taylor at the Cleveland meeting of the society. He fairly startled a large portion of the scientific men of the country, and they hesitated to endorse the method. To-day some of the very men are using his methods without saying much about the inventor.

The members of the American Society visited the University buildings, the library, the chemical and physiological laboratories and other points of interest, and expressed themselves as well pleased with the University and its equipments.

One of the noticeable events of the afternoon was the collation tendered the members of the American Microscopical Association, by the lady relatives of the members of the State Microscopical Society of Ohio.

In the evening there was a meeting of the American and State Microscopists and ladies at the parlors of the Park hotel. Several of the gentlemen displayed their skill in the use of the microscope, the instruments being furnished by the local opticians.

THURSDAY MORNING.

A business session opened with the election by ballot of a committee to nominate officers for 1889, as follows:—Professor H. J. Detmers of Columbus, Ohio; Professor W. J. Lewis of Hartford, Conn.; Professor F. O. Jacobs of Newark, O.; Professor W. H. Seaman of Washington, D. C.; Doctor Thomas Taylor, Washington, D. C.; Professor S. M. Mosgrove, Urbana, O.; and Henry Bausch, Rochester, N. Y. Professor Detmers having received the largest number of votes was announced as Chairman of the Committee. Nominations will be reported for the offices of President, two Vice-Presidents, and three members of the Executive Committee; the Secretary and Treasurer having heen elected for three years and holding over.

On motion, the society requested the Executive Committee to locate the next annual meeting at Buffalo, the time to be fixed later. The meeting will probably be held the week before that of the American Association for the Advancement of Science, to which quite a number of the microscopists belong.

The Society appropriated from the treasury $65 in aid of the Spencer-Towles Memorial Fund. Messrs. Spencer of New York and Towles of Boston were men of mark in the scientific world, and their admirers intend a memorial of some character when sufficient funds have been raised.

The working session was then begun, the following paper being read:—'Cellular structure of the black-pepper berry,' by Dr. Thomas Taylor, Washington, D. C.

Secretary T. J. Burrill, Champaign, Ill., spoke extemporaneously on 'The Ustilagineæ of Illinois,' which are the parasitic plants known as 'smut.' This is a low order of fungus growth, found especially on stalks of corn. Professor Burrill's paper showed careful research and especially deserves a place in the proceedings.

The paper of Dr. Leonard Pearson of Ithaca, N. Y., on 'Muscular coats of the æsophagus of domesticated animals,' was read by Mr. Sargent.

The papers of Messrs. Burrill and Pearson were ably illustrated with drawings and colored plates. The topics engendered some valuable discussions.

The session closed with an illustrated paper (the instrument being exhibited to and tested by the audience) entitled 'The Oleomargariscope, a New Form of Polariscope for Testing Fats,' by Dr. Thomas Taylor, Washington, D. C.

THURSDAY AFTERNOON.

Messrs. Simon Flexner of Louisville, Ky., and James Bull of Hanging Rock, O., were elected to membership.

The author being absent, the following papers were read by title:—"A new method of fine Adjustment" (of the microscope) and "A new form of Photomicrographic Camera," by E. H. Griffith of Fairport, N. Y. President Kellicott then read 'Observations on fresh-water Infusoria.' A paper by Professor W. A. Rogers of Waterville, Me., was presented by the following title only:—'On the Radiation of Heat between Metals by Induction and by Conduction with Numerical Results for Brass and Steel.' Mr. Drescher gave a description of a new Microtome made by Bausch and Lomb, Rochester, N. Y.

The rest of the session was devoted to demonstrations of practical microscopic work, the preparation and mounting of objects, etc.

The society first listened to Messrs. Reynolds of Detroit, Drescher of Rochester, Mills of Buffalo, Lazenby of Columbus, Lewis of Hartford and James of St. Louis, on various topics which they were about to illustrate or connected with the use of their microscopes and the preparation of their objects. There was also some good work done by Mr. Wellington of Jackson, Mich., and by Miss Booth of Longmeadow, Mass. The session embraced some rare microscopical demonstrations.

THURSDAY EVENING.

The most pleasant feature of the meetings, so far as an appreciative public is concerned, was the soiree. The tables were arranged in a hollow rectangle, and each microscope was provided with a lamp. A great many interested visitors came and went during the evening.

The soiree was managed by the Ohio State Microscopical Society in Wirthwein hall, at which place nearly all of the sessions were held. This was a

grand event, as about one hundred and fifty microscopes were exhibited, and from 200 to 300 objects could be seen by those present. Invitations were issued to many citizens of Columbus. The attendance was very large, and many ladies were there, including, in all, about 800 people.

In addition to the specimens arranged on slides, there were many shown by magic lantern.

The physicians of the city generally were in attendance, with their lady relatives and friends.

Drs. Detmers, Bleile, Weber, Hoover, and others were busily engaged during the entire evening in demonstrating the numerous objects which were viewed under the microscope. These gentlemen deserve great credit for the success of the soiree, and they became very popular with the visiting microscopists.

Among the exhibits were the following:—

By the Starling Medical College:—Liver of rabbit injected, intestine injected, salivary gland, living ciliated cells, kidney injected, tongue injected, cancer, trichina, flea from dog, hair of zebra, horn of rhinoceros, Moeller's Typen Platte (Genera of Diatoms), circulation of blood in foot of living frog.

By Bausch and Lomb:—Platino Cyanide of Magnesia (polarized), spicules of gorgonia, plumos quinidiæ, gold sand from California, ash, human tongue, proboscis of butterfly, proboscis of blowfly, trichinæ spiralis, Lord's prayer, diatoms, rare polycistinæ.

By Dr. Detmers:—Bacillus tuberculosis stained and mounted in balsam (700 dia.), trichina spiralis in pork.

By Ohio State University:—Skin of frog, spermatozoa, human skin with sweat glands.

By Miss Booth:—Fossil diatom from New Zealand, recent diatoms, Rhabdonema adnaticum, showing natural mode of growth.

By Simon Flexner, Louisville, Ky:—Tongue of a fly, Antipyrine (polarized light) cyclosis in anacharis canadensis.

By Prof. Weber, State University:—Cider vinegar, hoof of horse.

By H. R. Spencer & Co.:—Wheat weavel (with Spencer's $\frac{1}{2}$ inch), scales of butterfly (with Spencer's 2 inch, student's).

By Prof. W. R. Lazenby, State University:—Leaf of sun-dew, stem of snowball, of plantain, of fern, of young willow shoot, of pond lily.

By C. C. Mellor, Pittsburg, Pa.:—Skin of eel (polariscope), foot of honey bee.

By Wm. James, Columbus, Ohio:—Polycistina, signing of Declaration of Independence.

By F. O. Jacobs, M. D., Newark, Ohio:—Crystals of tourmaline in mica.

By W. H. Seaman, Washington, D. C.:—Globigerina from West Indies, Zoophyte or small coralline membranipora.

By E. L. Smith, M. D., Belfontaine, Ohio:—Gray's Elegy, 32 verses.

By D. E. Haag, M. D., Liberty Centre, Ohio:—Foot of house-fly, larva of mosquito, section of potato.

By Dr. Frankinburg:—Blood of the boa constrictor.

By F. Dienet:—Spiracles of cricket.

By Prof. D. S. Kellicott:—Head of simula (black fly).

By Salmon Hudson:—Wing of beetle, the diamond bee.

By S. M. Whitmore:—Fossil insect in Zanzibar gum.

Other specimens were as follows:—Star fish, crystals of salicine, mixed crystals, sting of wasp, eye of fly, red pepper stem, mallow seed, section of bulrush, stem of clematis, foraminifera, water thyme, eye of spider, pollen of œnothera, sting and poison-bag of bee, microbe of leprosy, tongue of honey bee, scalp of negro, shark's skin, kidney of kitten, section of horse's tooth, section of bone, section of liver, blood corpuscles, living diatoms.

FRIDAY MORNING.

Professor Detmers, Chairman of the Nominating Committee, reported the following ticket, which was elected by vote of the Secretary on motion to dispense with an election by ballot:—President, W. J. Lewis, M. D., Hartford, Conn.; Vice-Presidents, A. M. Bleile, M. D., Columbus, Ohio; F. L. James, M. D., Ph. D., St. Louis, Mo.; Executive Committee, F. O. Jacobs, M. D., Newark, Ohio; C. C. Mellor, Pittsburg, Pa.; Dr. W. H. Seaman, Washington, D. C. The terms of the Secretary and Treasurer not having expired, these gentlemen continue to hold their respective offices.

The next meeting will doubtless be held near the place of meeting of the American Association for the Advancement of Science, which meets at Toronto, since many members of the American Society are members of the American Association.

Treasurer S. M. Mosgrove of Urbana reported $679 receipts and $107 expended.

The society then adjourned, after which the members took the train to Newark, for the purpose of examining the prehistoric mounds at that place.

FRIDAY AFTERNOON.

The members of the society were the guests of the city, the mayor and other prominent citizens meeting them at the depot with carriages and showing them the objects of interest. This is in the very centre of the mound region of the Ohio valley, the ones located in the outskirts of Newark being among the most noted. These have been described by Squire and Davis, also by J. W. Foster, in his work entitled 'Prehistoric Races.'

The most striking mound is that at the fair ground, and it consists of a nearly circular embankment from 12 to 15 feet high and enclosing an area of 32 acres. Upon it are growing trees estimated to be 200 years old. One measured 11½ feet in circumference. Inside, and not outside as we would expect, is a ditch 5 to 10 feet deep. There is but one entrance to the enclosure. The systems of smaller mounds and embankments, varying from a few inches to several feet in height, were traced for long distances. Lunch was served by the Newark ladies at the fair ground.

Before lunch the Hon. C. B. Giffin, standing upon a mound which imagination styles an Eagle, and located in the centre of the so-called 'Fort,' read an address on the archæology of the place. The group was photographed by Mr. Drescher of the Bausch and Lomb Optical Company, Rochester, N. Y. After that several hours were spent in riding about to view a number of other mounds in the vicinity.

The party returned to the city about 5 P. M., and different parties made short excursions from the Tubbs House during the next two hours, visiting the collections at the county court-house and elsewhere.

FRIDAY EVENING.

At 7 o'clock about 100 people, including prominent citizens, sat down to dinner in the Tubbs House.

After the dinner, Mr. Giffin called the assembly to order to listen to Judge Hunt, who welcomed the visitors in the name of the city. Speeches in reply were made by Dr. Bleile, Professor Kellicott, Dr. Lewis, and Dr. Detmers. The latter created amusement by presenting a pair of stuffed frogs, each represented as gazing down the tubes of a microscope. The work was by Mr. Wellington, of Jackson, Mich.

At its conclusion and before leaving the tables the final meeting of the society was held. Professor Kellicott contrasted the present with the first meeting held ten years ago at Indianapolis, when but 49 persons were present (13 from New York, 14 from Indiana, 8 from Illinois, and 5 from Ohio).

He thought there was no society composed so largely of professional men, nor having such an *esprit de corps*. He said Microscopy had so grown in this decade as to make parts of the first volume of proceedings now seem like boyish talk.

Prof. W. H. Seaman presented resolutions of thanks, which were heartily seconded by the society. They mentioned the kindness of the Mayor and municipality of Newark, of the State Microscopical Society of Ohio, of the ladies of Columbus, and of the vocalists and instrumentalists who furnished music the first evening.

Professor Kellicott thanked the society for the presidential honors he had enjoyed, and surrendered the chair to Dr. Wm. J. Lewis. The latter paid his respects to the society, and pronounced the meeting adjourned.

After another hour in social enjoyment the visitors took the return train for Columbus, where they arrived somewhat past midnight. They then scattered not to reassemble until 1889.

A Starch Injection Mass.*

As prepared by Prof. S. H. GAGE,
ITHACA, N. Y.

A coarse injection mass, which is cold-flowing, may be forced nearly to the capillaries, rapidly hardens after injection, leaves the vessels flexible, does not dull dissecting instruments, is suitable for permanent dry or alcoholic preparation, is simple in its manipulation, cleanly and economical, seems to be fully realized in the starch mass introduced by Ad. Pansch of Kiel.

MASS FOR ORDINARY INJECTIONS.

Dry starch ('laundry' is good),	100 c.c.
Water or a 2½ per cent. aqueous solution of chloral hydrate,†	100 c.c.
95 per cent. alcohol,‡	25 c.c.
Color mixture, see below,	25 c.c.

After thoroughly mixing the mass it should be filtered through one or two thicknesses of moistened paper cambric or cheese cloth. To prevent the starch from settling, the cloth should be tilted from side to side or the mass may be stirred during the filtration. If the mass is not freshly prepared for every injection, the stock mass should be filtered occasionally to remove hair or any other object that might clog the cannula.

Since almost any animal injected may afford some organ worth preserving, it seems better to employ permanent colors for tingeing the mass. Among those which are available, probably vermilion, red lead, ultramarine, Berlin blue, chrome orange, yellow, or green, are preferable.

PREPARATION OF THE COLOR.

Dry color,§	100 c.c.
Glycerin,	100 c.c.
95 per cent. alcohol,	100 c.c.

*Since many of our readers may not have met with this method for injection for coarse anatomy, we introduce it here from the *N. Y. Medical Journal*. It is especially useful for the laboratory, because no heat is required in using the mass as is the case with the gelatin fluids, and because it does not set rapidly as does the plaster.

†The chloral and alcohol prevent fermentation in the mass when it is kept in stock; the alcohol also increases the fluidity and likewise the more rapid hardening in the vessels; both, of course, act as preservatives upon the animal injected.

‡The mass originally recommended by Pansch consisted of wheat-flour and cold water, to which was added a sufficient quantity of the desired coloring matter. Later experiments have shown that pure starch is better than flour. As starch is insoluble in alcohol and cold water, it becomes hard when injected into the blood-vessels simply by the exudation of the liquid with which it is mixed. That the starch grains forming the mass remain entirely unchanged may be easily demonstrated by making a microscopic examination of the contents of an injected vessel.

§If Berlin blue is used to stain the starch, 25 c.c. of the dry blue are dissolved in 100 c.c. of water or a 5 per cent. aqueous solution of chloral hydrate.

To avoid lumps, which would clog the cannulæ, or small vessels, the color is thoroughly ground with the liquid in a mortar. It is stored in a well-stoppered bottle, and is prepared for use simply by shaking. If permanent preparations are not to be made, the mass may be stained by an aniline dye of the desired color.

Special Mass.—For the injection of brains, and, perhaps, for other rapidly perishing specimens, it seems best, as suggested by Prof. Wilder, to use strong preservatives in preparing the mass:

Corn starch (that used for food), ...	100 c.c.
5 per cent. aqueous solution of chloral hydrate, ...	50 c.c.
95 per cent. alcohol, ...	75 c.c.
Color mixture, ...	25 c.c.

For convenience and economy, a considerable quantity of either of the masses described above may be prepared at once, and kept in a wide-mouthed specimen or fruit jar; but the mass must be thoroughly stirred before using. The syringe may be filled directly from the jar, and any mass remaining in the syringe after the injection is finished may be returned to the jar.

If it is desired to have the mass enter very fine vessels, some of the stock mass, as given above, diluted with an equal volume of water or chloral solution, may be injected first, and immediately followed by the undiluted mass, or, for large animals, a mass containing twice the usual amount of starch. In whatever form the starch is used, it is necessary to work somewhat expeditiously, because the exudation of the liquid in the smaller vessels takes place so rapidly that the mass hardens very quickly in them. The larger the vessel, the more slowly, of course, do the exudation and, consequently, the hardening take place. It sometimes happens that large vessels, like the aorta, are not fully distended after the exudation of the liquid. In this case some mass containing double the ordinary amount of starch can be advantageously injected in two hours or longer after the first injection.

In animals as large as the cat, and larger, the great veins of the trunk would perhaps better be injected with plaster, as the presence of blood in them prevents or greatly retards the hardening of the starch.

Permanent preparation.—If a permanent wet preparation is to be made of a starch injected animal or part, the cut end of the vessels must be tied in order to prevent the gradual escape of the starch.

Finally, if vessels injected with the starch mass are dissected free, soaked a day or two in Wickersheimer's preservative, and then dried, they retain their form, and, to a great degree, their flexibility.

Cornell University, *Sept., 1885.*

REPORTS OF RECENT ARTICLES.

What is Cancer?—Dr. Jas. Braidthwaite, of Leeds, England,* seeks the cause of malignancy of epithelial proliferations, while muscular and fatty growths are harmless. He thinks an answer is found in the properties of epithelium-cells they being such that if they proliferate, encapsulation is impossible. All epithelium is normally underlaid by a basement membrane which encapsulates it, and, if the growth does not penetrate the basement epithelium, the growth is not malignant. Microscopists, to judge of malignancy, study the base of growth. The properties of epithelium-cells to be noted in this connection are:—1. The relative natural hardiness of the cells. 2. The rapidity of growth and reproduction. 3. The ordinary mode of death. 4. Existence or not of a natural secretion. 5. Contour of the sur-

* *Lancet*, June 30, 1888, p. 1287.

faces of the cells. 6. Shape of the cells as a whole. 7. Shape of the surface of the growing mass, whether flattish or consisting of numerous processes. 8. Relation of blood vessels to the growing mass. 9. Degree of compressibility of individual cells. 10. Degree of cohesion between the cells.

An epithelium cell is most hardy, for it lives separated from blood by basement membrane, and often by other cells. It often receives nourishment at one end only of cylinder cells. Such a cell, then, if it penetrated the basement membrane, would seem able to outstrip competitors of other tissue. The epithelium cell is also a rapid grower. Its ordinary mode of death is by abrasion, while the ordinary mode of death of mesoblastic tissues is by fatty degeneration and resorption. In the protected situation, and well nourished, we may easily suppose the epithelium cell to be endowed with great vitality. The epithelium is very incompressible and of angular contour. Hence accumulations would force them through basement membrane, and the mass is also angular, which would force it out among the tissues. In competition with them they would come out the worse. The cells also have a secretion of their own which does not escape, and they are not very closely attached to each other. Thus single ones can become detached and force themselves into new situations. For these reasons encapsulation is very unlikely in epithelial growths. In encapsulated growths, as fatty tumors, the normal parts with their blood vessels are merely thrust aside, but where the basement membrane is broken through the normal tissues are invaded. Fatty tumors contain no blood vessels; epithelioma are vascular. This, then, answers the question why epithelial proliferations are malignant, while others, *e. g.*, fat or inorganic muscle, are not so.

A second question arises, how does epithelium get below the basement membrane? There are two modes of answer:—1, great pressure from growth; 2, weakening of basement membrane. Both may co-operate. The former may result from various causes:—1. A blow, *e. g.*, on the breast without lesion of skin, but a deeper injury. 2. Gland with age may have lumen blocked. 3. Result of mechanical pressure, *e. g.*, a pipe on the lips. 4. Excited growth in the deepest layers may cause to burst the epithelium as the easiest outlet.

How is the proliferation caused? Perhaps by removal of the force of formative restraint which keeps a balance among tissues, or by the addition of an unknown force. Old age or carnivorous diet seem to be disposing causes.

QUERIES.

1. What is the most convenient way to catalogue and arrange histological and pathological specimens; about 1,000?—V. A. L.

A.—From our own experience we should answer the question as follows:—In working out a study in molluscan embryology, which required the cutting of 75 embryos and of 200 sections of each embryo, the problem of how to find anything in particular soon became a very pressing one. We numbered the series of sections with a number for each embryo, and the section in each series from its particular place in that series. The whole set of sections was kept together and designated by the name of the animal under investigation. We could then readily refer most minutely to any section in the entire collection. Fasc., 5, 23, for instance, meaning a certain small spot, by examination of which we should see a certain peculiar cell nucleus, or some other minutiæ, which a tiresome search might not otherwise discover. To find these places a catalogue was then made by subject, with references as above. We consider the best mode of arrangement to be, first, by organ, the sections of any one organ being numbered, and if several sections of the same piece are cut these receive additional numbers; thus, liver, 6, 5, would be the designation of a particular section in a series.

We then prepare by subjects a card catalogue, with references to the section by number. This card catalogue need not be prepared all at once, but only as study of different subjects makes it desirable. Thus, normal unstriped muscle would have many references, as, for example, intestine, 5, 23, 27; stomach, 19, 8, etc. This catalogue of the contents of the cabinet is, of course, entirely distinct from the list in which the record of the technical history of the slide is kept. Such a working table of contents of the collection is of great value, because it permits an indefinite number of cross references. Stomach, 19, 8, may illustrate not only normal unstriped muscle, but normal gastric follicles, and various morbid phenomena, under all of which heads it is referred to.—H. L. O.

2. What is the best method of making sections of buds to demonstrate estivation and venation?—V. G. L.

A.—Probably the paraffine imbedding as practised by Moll (*Journal*, 1888, p. 86). It would depend, however, upon the age of the bud. If flower buds only were studied the method would leave nothing to be desired, for serial sections could be cut. With woody buds its application would be less satisfactory, except when very young.—H. L. O.

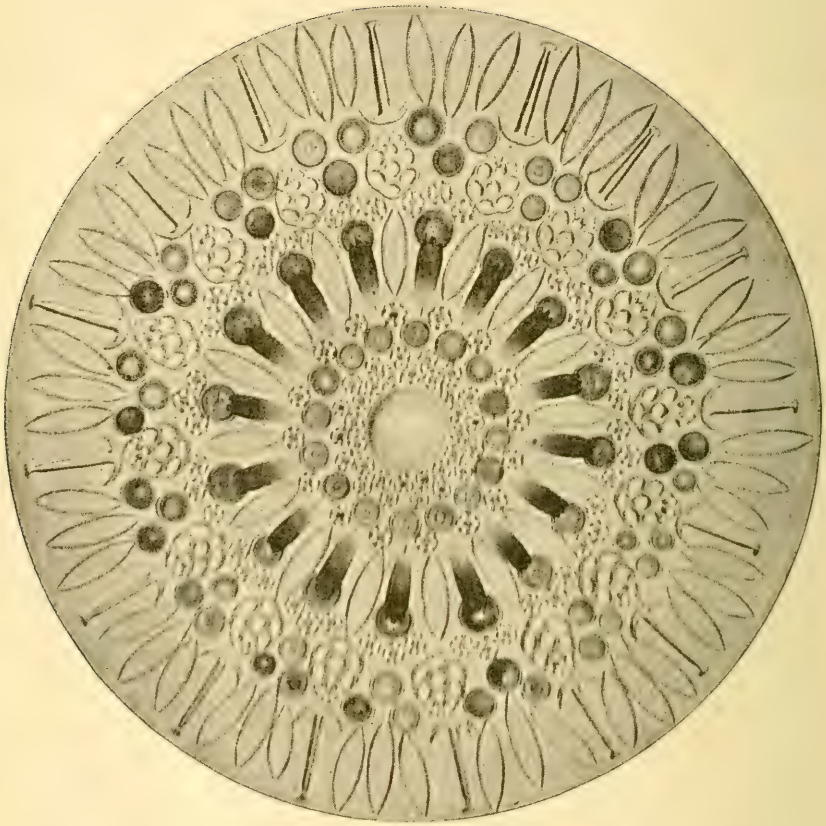
NOTICES OF BOOKS.

Synoptical Flora of North America. The Gamopetalæ. By Asa Gray. Smithsonian Institution. Washington, D. C., 1888.

It is now nearly forty years since the late Dr. Gray, in conjunction with Dr. John Torrey, undertook to write a work upon the flora of the entire North American continent. One volume and part of a second were published, systematically, reviewing the known facts of the flora as far as through the order Compositæ. Later, in 1878, Dr. Gray published a continuation of the work, which included everything known in North America from the Compositæ through the Gamopetalæ. The volume now issued through the generosity of the Smithsonian Institution, as No. 591 of its publications, comprises all the Gamopetalæ, being a complete revision of the latter part of Torrey and Gray's Flora, and a reprint of the Flora dated 1878, with supplements, bringing the latter down to date. The first part consists of 480 pages, including a supplement of 11 pages, and an index of 24 pages. The second part consists of 392 pages, printed from the 1878 stereotype plates, with a few corrections and a supplement. This is followed by an enumeration of genera and of species, and by a complete index. The volume of 942 pages represents an amount of work which only the student who has attempted a similar task can comprehend, and it was only part of the work of a very busy scientist. Review articles, essays, the practical study and collection of the immense herbarium at Harvard, and for many years a large amount of class-room work in Harvard College, occupied Prof. Gray's time. Now for a decade it has been understood that the author's time was almost exclusively his own for the completion of this great work. He has left behind not only this completion of a part of his projected work, but a large amount of partially finished material, so that the Flora may be completed before many years.

Of the character of the work which has been done, and which is now given to many anxious readers, no one can say too much in praise. It represents an enormous amount of careful research by a most careful and faithful student. The descriptions are brief and pointed. There is no exhaustive synonymy, but a note of the synonyms, and a few most important references for the original diagnoses. The name synopsis would indicate the book to be little more than a list, but every plant given receives a complete diagnosis, occupying somewhere near the space so devoted in Gray's Manual. There are in all 567 genera and 3,521 species described, of which 525 genera are indigenous, 162 species are introduced from Europe; so that the North American Gamopetalous flora includes 3,359 native species. The number of species of the genus Aster described is 124. It is the largest genus, and Solidago, with 78 species, comes second.

A word of thanks ought to be in the mouth of every user of the "Flora" to the Institution which has placed it within their reach. None but the professional botanists will require it. They will find it indispensable. The number of these is too small to permit the publication of such a work as a private enterprise. It is understood that Prof. Sereno Watson, who has for many years worked with Prof. Gray, and has had charge of the Herbarium, will continue the Synopsis. It is to be hoped that at no very distant date the final volume may be issued.



RINNBOCK'S SLIDE OF ARRANGED DIATOMS, CHIRODOTA WHEELS, SYNAPTA PLATES
SYNAPTA ANCHORS, ETC., ENLARGED 150 DIA.

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Rinnbock's Slide of Arranged Diatoms, Chirodota Wheels, Synapta Plates, Synapta Anchors, etc.

BY CHAS. W. SMILEY.

The arrangement of 289 microscopic objects inside the space of a pin-head is a noteworthy accomplishment. When, in addition, they are made to present a regular and harmonious picture of great beauty, some praise ought to be accorded the artist. In the case illustrated by the frontispiece, the work was performed by Mr. J. C. Rinnbock of Wien, Austria. The slide is now the property of Miss M. A. Booth, of Longmeadow, Mass., who has kindly consented to have the engraving made and who has identified the objects. The slide was recently photographed by Mr. W. O. Tasker, of Haverhill, Mass., and his photo-micrographs are beautiful specimens of the art. From one of these a photo-engraving company has made an engraving by the 'Half-tone process,' thus enabling the printer to make copies by the ordinary printing press. Considerable skill was, however, necessary in putting it upon the press, keeping it clean and working it carefully. Mr. John Gibson, of the firm that prints this periodical, kindly gave his personal attention to the work. The engraving, of course, falls short of the photograph, and even the photograph does not reveal the colors and other beauties of the objects. It is to be hoped that Miss Booth will exhibit the slide at the next meeting of the American Society of Microscopists.

In order that all, whether microscopists or not, may understand the engraving, a brief description of its contents is appended.

The central object is a diatom of the family *Coscinodisceæ*, genus *Coscinodiscus*. The beauty of this object, due to the regularity of hexagonal areolation of the valves, does not appear in the engraving. A description and good figure will be found in Dr. Carpenter's work, The Microscope, pp. 347–8.

First and Second Rows.—The two rows next to the central object contain 32 wheel-like plates from the skin of *Chirodota*, a Mediterranean genus of Holothurian. Under the microscope they present a singular beauty and delicacy of notching around the inner margin of the tire of the wheel. (cf. Carpenter, p. 641).

Third Row.—The third row from the centre is made up of 16 specimens of the genus *Actinocyclus*,—a diatom closely related to *Coscinodiscus*. The difference is in the marking of the disks but cannot be clearly seen in the plate. In this case there are dotted lines radiating from the centre. Unfortunately the photo-engraving does not show the beautiful shades of brown, red, blue or purple which the object reveals under the microscope.

Fourth Row.—This consists of 16 *Chirodota* wheels, like those in the first and second rows.

Fifth Row.—In the fifth row are 16 scales from the wings of *Lepidoptera* (butterfly). These are the darker elongated objects, three-toothed on the outer margin. Alternating with them are 16 longer objects resembling in outline double-convex lenses. These are diatoms of the genus *Surirella*.

Sixth Row.—The 16 diatoms in this row, called *Actinocyclus*, are like those in the third row, and are each placed at the crenate ends of the butterfly scales of row number five.

Seventh Row.—Here 48 more wheels of *Chirodota* are arranged in triplets outside the *Actinocyclus* of row number six.

Eighth Row.—The 16 oval-shaped objects in this row are spines or scales of *Synapta*. This genus belongs to the *Echinodermata*, order *Holothuria* and abounds in the Adriatic sea. These plates, as they are called, project from the surface of the skin and serve somewhat the same purpose as the wheel-like plates on *Chirodota*, an allied genus to *Synapta*. Each of these calcareous plates carries seven oval disks of considerable size and as many more minute ones at the outer end. Alternating with these plates are triplets (48 in all) of *Actinocyclus*, like those in other rows.

Ninth Row.—The ninth or outer row is made up of 16 anchors of *Synapta*, and 48 diatoms, *Surirella*. The latter are like those in the fifth row. The anchors are from the same genus as the scales in row number eight. These anchor-like spines grow attached to the acute ends of the plates described above.

The whole constitutes a remarkable illustration of recent art, not only in microscopy but in photography and engraving.

WASHINGTON, D. C., *October* 20, 1888.

Notices of Microscopical Methods.*

BY DR. M. NIKIFOROW,
MOSCOW.

I. *A carmine for nuclear staining.*—In spite of the immense number of stains at present in vogue, carmine, at first discovered by chance, remains in many respects the best. A modification of carmine staining, valuable either for isolated nuclear staining or for diffuse staining, either of the section or of the piece *in toto*, is as follows:—

First. Boil in a porcelain dish 3 parts of carmine, 5 parts of borax, and 100 parts of water.

Second. To this mixture, which will not dissolve the carmine thoroughly, add ammonium hydrate until the carmine dissolves. The color of the solution will now be cherry-red.

Third. Carefully neutralize the solution with acetic acid and the color will change to a beautiful rose tint.

The section may now be stained in the neutral carmine, if nuclear staining alone is desired, or it may be stained in carmine with an excess of acetic acid if diffuse stain is wished. For sections, 15 minutes will be enough in the stain, but the section may remain 24 hours without injury, and for pieces 24 hours will be required. After staining, the excess of staining fluid is to be washed out by immersion in distilled water until the water ceases to be tinted by the piece. The color works best in alcohol-preserved material, but can also be used with chromic acid specimens if they have not lain in chromic acid two weeks or over. By adding a very minute quantity of carbolic acid to the ammonium-borax-carmine solution the growth in it of moulds will be prevented.

II. *Safranin for staining central nervous tissue.*—Prof. Adamkiewicz first called to attention that safranin would give with nerve tissues hardened

*Condensed and paraphrased from the original article in Zeits. f. Wiss. Mikros., Sept., 1888, p. 337.

with chromic salts an elective differentiation, the medullary sheath being rose-colored, nuclei of nerve and neuroglia cells and the vascular cells being violet. Further, he discovered that the nuclular substance would not stain if the nerve had been diseased, and at a time when no mode of tracing diseased nerves was known. But since his method does not always perfectly distinguish the medullary sheath, the color difference not being well enough displayed, a modification of his method is proposed which has proved valuable.

The hardening of brain or cord having been effected in Müller's fluid, or ammonium bichromate, the reagent is not to be washed out with water. Sections must be transferred at once from alcohol to a concentrated watery saturated solution of safranin, where they are to be overstained (24 hours). From the staining fluid the section must be transferred to alcohol, where they are gently agitated until the grey substance begins to be unlike in color to the white substance, when, with a thick glass rod, the section must be transferred to a weak solution of a metallic salt—gold chloride or platinic chloride ($\frac{1}{500}$ or $\frac{1}{1000}$). Here the section must remain until the grey substance has assumed a violet tint. If the section remains too long in this solution, the staining will prove a failure. From the gold solution the section is transferred to alcohol, and left there till the grey substance has assumed a rosy-violet color and the white substance forms a distinct red ground. Then the section is mounted in balsam in the usual way, and it will show a far clearer differentiation of its different parts than when stained by the customary safranin method.

Studies for Beginners.—IV.

By H. L. OSBORN.

THE YEAST PLANT—(*Continued from p.* 86).

5. **An experiment.**—To follow the present article and to prove by observation the facts which will be stated, the student should procure some fresh yeast, and for 48 hours allow some to stand in a thin solution of sugar and water; also, some in rain-water. The yeast in both cases will be noticeable as a white sediment upon the bottom of the cup or tumbler. For microscopic examination, a drop of this sediment may be taken up with a dropping-tube and be deposited upon a slide. Cover it with a glass circle and examine with a power of 350 diameters. But, before this microscopic examination is made, first notice some of the facts which can be learned with the naked eye. After 48 hours, particularly if they have been kept mildly warm (70° to 80° F.), the contents of the cups show a marked difference. One is turbid and bubbles arise to the surface; it is no longer sweet, but is becoming sour, and will become quite so. If means of testing were at hand considerable alcohol would be found to have in some way gotten into the water. In the other cup nothing of this sort is to be found. The water remains clear, does not become sour, and does not contain alcohol. Obviously something has taken place in the sugar solution due to the presence of the sugar, for both preparations are by design alike, except as regards the sugar. In the laboratory at Hamline University last spring, while some students were at work upon yeast, they kept their solutions in corked vials. Invariably, after a time, the corks were blown out of certain vials with loud explosive reports. This never happened with those containing pure rain-water and yeast. The two may now be compared microscopically.

6. **Yeast from the sugar solution.**—In making the mount for examination caution must be taken not to have the yeast too thick. Put on a drop of water with the yeast, and add another drop of clear water if the yeast looks very thick. Examination will now reveal a very different looking yeast plant

from the single oval body of the inactive yeast first examined. In place thereof oval bodies, sometimes several of them, have grown together. In fact, there is now before us actively growing yeast. The process of growth in yeast is called budding. The steps can be readily traced. There grows at first on one spot a little pimple, which enlarges until eventually it rivals the size of the original cell from which it derived its origin. Not uncommonly two of these little pimples or buds, as they are named, arise at the same time on a yeast plant. Both then increase in size. Before they have grown to full size, one or both of the buds may in turn have produced a bud, constituting a third generation derived from the original yeast cell. In actively growing yeast this goes on so rapidly that one may not improbably find a cell carrying two buds, which in turn each carry one or two. These in turn also bear buds. In an example before us twenty yeast plants are thus connected which plainly have grown from a single cell. All the separate ovals are like the original yeast plant in three particulars. They all have a cell-wall, a protoplasmic substance, and some fat droplets. But the older ones differ from the younger ones in two particulars—(1) they are larger than the youngest ones, and (2) the vacuole more nearly occupies the whole of the space inside the cell-wall.

7. **Yeast from the rain-water.**—While the yeast from the sugar has grown extensively by budding, and the bulk of yeast has been vastly increased, that left in rain-water has done nothing of the kind. It has not budded, but is, in shape, made up of single oval cells, with some carrying one bud or at most two. They do not look like the luxuriantly budded plants of the sugar and water solution. Close observation will, however, reveal a still more significant fact than the absence of budding. The yeast plants prove on careful scrutiny to be only empty cell-walls containing only a few very small bodies, which may perhaps be the remains of the fat droplets. The protoplasm has gone and the yeast is all dead. It has *died of starvation!* That the yeast is dead could be proved by putting some of it in the sugar solution and noticing it did not bud. But to do this certain precautions would need to be taken to prevent the introduction of any live yeast. This would require considerable skill, and cannot be attempted in an elementary course.

8. **General conclusion.**—There have now been observed, with the microscope and with the naked eye, the evidences of life and growth in the yeast plant. This sketch will be completed by noticing briefly the meaning of some of the observations. One would be likely to reason that sugar in the water kept the yeast alive by furnishing it with food. That this is the case is shown by the fact that the sugar gradually disappears, and if not renewed the yeast dies. In getting its food from the solution the yeast lets loose from the sugar the alcohol which it does not require. It has increased very considerably in aggregate bulk, and the substance for this increase has been made in part from the sugar. Since this substance is made only in part from the sugar, something else should be furnished in the solution for food. Unless it is, the yeast will only thrive for a few days. This is not a time to go more fully into the life-processes of the yeast plant. One word will suffice by way of comparison with Protococcus, which *can* live in pure rain-water. It has a power, because of its green coloring matter, which the colorless yeast plant does not possess—that of making its food out of gases which abound in the air.

The growth of yeast in a sugary solution is known as fermentation; it is attended with the evolution of carbonic acid gas. The report remarked above was due to the fact that this gas accumulated in the vials until it produced a high pressure there and finally forced out the cork. There are many other plants which in their mode of life and growth closely resemble yeast.

Microscopical Examination of Drugs.

By Prof. H. M. WHELPLEY.

In order to examine the structure of a root, tuber, rhizome, stem, wood or bark, the drug should be cut at right angles to the axis. I find a scroll-saw very convenient for such work, but any small saw or sharp knife will answer the purpose. The freshly-cut surface of one of the pieces should be rubbed on sand-paper or a flat file to make it smooth. Some drugs will show the structure, as far as it is described in the Pharmacopœia, without aid of a microscope. This is especially the case when the cut surface has been moistened. The next step is to soak the drug, or at least the end to be examined, in water until it has swollen to about its natural size. This can be determined by the absence of wrinkles on the surface of the drug. The exact time to thus macerate varies with each drug, and is also influenced by temperature. The danger is in soaking it so long that the soft parenchyma tissue is distorted. The drug should then be transferred to glycerin for a few hours, and it is ready for examination. Place a cover-glass, or a piece of any thin glass, over the cut surface and let it remain by adhesion. Examine by aid of good light, and it will surprise you to see how easily the coarser structure can be determined.

To examine seeds they must be cut in sections and mounted as described in the various works on pharmacognosy and microscopy. Leaves that can be advantageously studied in this manner are few. Buchu is the only official one that is described microscopically. The appearance of the hairs on digitalis and a few other leaves should be described, as they can thus be distinguished from other leaves accidentally or fraudulently added. The official description is suitable for the entire leaves, but is not sufficient to identify some of the pressed drugs or broken ones found in the market.

Such drugs as lupulin, lycopodium, etc., must be mounted in glycerin, or some other liquid, after well-known methods. Make it a rule to select good samples of drugs for examination, and become familiar with their structure. The Companion to the United States Pharmacopœia and Maisch's Organic Materia Medica are both valuable works for reference in the study of the structure of drugs.

Aconitum.—'Whitish internally, with a rather thick bark enclosing a star-shaped pith, about seven rayed.'* In order to make out this structure, cut a root transversely about midway of its length. Macerate in water for six to twelve hours, and then in glycerin for twenty-four hours. Cover the section with a thin cover-glass, and allow the glass to stick to the drug by adhesion. The structure can be made out with a power of ten diameters, even by aid of lamp-light.

Aloe.—'Mixed with alcohol and examined under the microscope it exhibits numerous crystals.' I found several samples of the official (socotrine) variety of aloes that did not show these crystals. In others they appeared as a yellowish-red sediment, the individual crystals not being over twenty-one to twenty-six micromillimetres (1-1,250th to 1-1,000th of an inch) long. The best results were obtained by mixing a small quantity of aloes with an equal quantity of alcohol, and examining a thin (250 micromillimetres) film with a 1-5th-inch objective and two-inch ocular. Good illumination is essential. As these crystals are of aloin, the drugs that do not show them must be of an inferior quality. Some specimens of Cape and Barbadoes aloes showed much larger crystals, some of them being about 500 micromillimetres (1-50th of an inch) long. The crystals are all prismatic and easily distinguished from fine particles of sand that are to be seen in the field. There is also oc-

*The quotations are all from the 6th Decennial U. S. Pharmacopœia.

casionally present a few fibrovascular bundles that look somewhat like crystals.

Amylum.—'Under the microscope appearing as granules, mostly very minute, more or less lenticular in form and indistinctly, concentrically striated.' I was unable to procure the officinal wheat starch in the market. The wholesale trade handle only corn starch. The granules of corn starch are always isolated, and average about 7-10,000th of an inch (20 to 30 micromillimetres) in diameter. They are quite uniform in size and polyhedral in shape, with rounded corners. The hilum is well developed, and appears as a star-shaped or round depression in the centre of the grain. The rings are faintly seen. Wheat starch grains are much larger, twelve to fifty micromillimetres (18-10,000th inch), than corn starch, but very irregular in size and appearance. To examine starch, mix a small quantity with glycerin and use a two-third, one-half or quarter-inch objective. If a polariscope is at hand, mount in balsam and examine with or without selenite. The mounts in either glycerin or balsam are permanent, but the latter medium renders the grains too transparent for examination without the polariscope.

Anisum.—'Consisting of two pericarps each with about fifteen oil tubes, which can be seen in transverse section by the microscope.' A power of ten diameters is scarcely sufficient to distinguish these ducts, but a Coddington lens of twenty diameters power will show them. The sections must be carefully made or the filiform ridges and oil tubes will be broken off.

Buchu.—'Crenate or serrate, with a gland at the the base of each tooth.' Place the drug on a sheet of white paper and examine with the officinal microscope. A serviceable mount is made by carefully pressing a leaf between two slides and binding the glass together with gummed paper. This can be examined by either reflected or transverse light. The glands show equally well from either side of the leaf.

Gossypium.—'Under the microscope, appearing as flattened, hollow and twisted bands, spirally striate, and thickened at the edges.' The ten diameter microscope is of no avail whatever here. The lowest power that will satisfactorily show this structure is an amplification of about thirty diameters, although twenty will answer the purpose. Examine the fibres in glycerin.

Hydrargyrum cum Creta.—'Continue the trituration until the globules of mercury are no longer visible under a magnifying power of ten diameters.' The test is easily made, but strong light will show bright metallic particles in the commercial preparation, although it requires a higher power to show that they are globules.

Kamala.—'Under the microscope, is seen to consist of stellately arranged, colorless hairs, mixed with depressed globular glands, containing numerous red, club-shaped vesicles.' My experience has been that the description should state that the stellate hairs are mixed with the glands, as the latter are by far the more numerous of the two. They vary greatly in size, but average about eighty-four micromillimetres (1-300 inch) in diameter. They show fairly well when mounted in glycerin, but should be treated with a solution of potassa in order to show the structure described. The stellate hairs have no resemblance to the stellate hairs found on the leaves of *Verbascum.*

Lupulinum.—'Minute granules which, as seen under the microscope, are globular, or sub-globular, or rather hood-shaped, and reticulate.' I find these granules to average 189 micromillimetres (3-400th of an inch) in diameter. It requires a power of forty to fifty diameters to make out the above structure, although the granules can be seen under a much lower power. An alcoholic solution of potassa will clean them nicely, and glycerin is a suitable medium for examination. I find that some of the older works give very vague descriptions of these granules.

Lycopodium.—'Under the microscope, the granules are seen to be four-sided, reticulated, with short projections on the edges.' There is but little use of examining these granules dry. They can be mixed with glycerin and examined with powers from 125 to 200 diameters. The granules average about twenty-eight micromillimetres (1-900th inch) in diameter.

Massa Hydrargyri.—'Continue the trituration until globules of mercury cease to be visible under a lens magnifying ten diameters.' The remarks made about mercury with chalk also apply to blue mass.

Unguentum Hydrargyri.—'Continue the trituration until globules of mercury cease to be visible under a magnifying power of ten diameters.' This test is too severe for the commercial mercurial ointment. I find that the large globules average about sixty-three micromillimetres (1-400th of an inch) in diameter and are readily seen by aid of the power designated. This forms a very pretty specimen for a power of fifteen or twenty diameters. The globules of mercury settle to the lower side of a slide, so the position should be occasionally changed.

(*To be continued.*)

Notes on the Technique of Frozen Anatomical Sections.*

By D. S. LAMB,

U. S. MEDICAL MUSEUM.

The part to be frozen should be in precisely the position desired, and free from folds or depressions of the skin. It should be frozen so that all parts, bone, etc., will cut alike. The section should be cut in a cold room, the saw being cold and very sharp. When made, the section will be found to be covered with sawdust. The amount of this will be greater if the freezing be not complete. It has been recommended by some to pour hot water over such a section, then scrape the dust away rapidly and carefully. This is a very delicate part of the process, and its successful performance has much to do with the appearance of the specimens. In my opinion, however, after a great deal of experience with alcoholic specimens, it is best to place the section at once on a plate of glass, and lay it in a dish of cold alcohol. After the usual hardening, there is then no difficulty in working off any loose matter by using a stream of water. It is an advantage to have the vessels injected before freezing. The contrast is greater, and they are shown with greater distinctness. The alcohol used in hardening should be renewed a few times; the first renewal within a few days, or a week at the most; the second renewal will depend on the thickness of the section. For freezing, a low, dry temperature is best; below zero. But if the box be exposed to a low temperature for several days, then a night of + 10° F. may freeze it. A freezing mixture of ice and salt also will do the work. The melted water must, of course, have a chance to run off.

The great advantage of frozen sections is the almost absolute accuracy of relations which are obtained, and not obtainable by any other method. The slight increase in size produced by the freezing is, no doubt, fully balanced by the contraction produced by the cold upon the contractile tissues. While the frozen section is still hard, a plaster cast may be made, and from this another (the reverse), which will resemble the section, and may be colored to life afterwards. Such a cast is very useful for instruction, and has the advantage of preserving at a cost less than that of preserving in alcohol.

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* Read at the 79th meeting of the Washington Microscopical Society, Washington, D. C.

Biological Notes.

By L. W. CHANEY,

NORTHFIELD, MINN.

Trematodes.—The writer has, for some years, as he was able, been giving attention to the embryology of the fresh-water mussels. During one stage of their life-history the embryos of these mussels live in broods pouched upon the sides of fishes. In searching for these pouches, occasion has been taken to dissect some of the fishes, and in them have been found encysted forms which seem to be one generation of Trematodes. If this should prove true, preceding stages should be found in our snails.

A brief sketch of the life-history of some of the Trematodes may suggest lines of investigation which the worker with the microscope and scalpel might undertake with interest and profit. The small eggs passing from the host with the excretions, and falling in some damp place, go through the usual segmentation, and become ciliated embryos having some features of the adult worm. These embryos, boring into the tissues of the snail, assume a state called a Sporocyst when without mouth and alimentary canal; in other species a Redia, with mouth and alimentary canal. Within the Sporocyst, or Redia, there arise a number of oval larvæ having a muscular tail of considerable length. These larvæ burrow out of the cyst and from the body of the snail. Swimming about, by means of the strong tail, they find a new host, frequently a fish. Into the tissues of the fish the larva called a Cercaria forces its way, and there becoming encysted, assumes the form of the adult except that the generative organs are not developed. The fish being eaten by some other animal, the larva set free undergoes a final metamorphosis, and assumes the adult and sexually mature state. It thus appears that in three different animals may be found three stages of the same worm. Of these three stages the writer has casually met with one. He would be very glad of hints from any source which would throw light upon the matter.

Tape-worms.—In a letter, Prof. C. W. Hargitt, of Miami University, mentioned finding a number of tape-worms in the small intestine of the cat. In such literature as is at hand, no mention is made of this as a common occurrence. One species is named as so occurring with its larval state in the field-mouse. As, at the time, a number of cats were under examination in our laboratory, they were dissected with a view to noting their condition in this respect. Curiously, the only one of the animals affected was one in the habit of hunting in the fields. Those cats whose habits were strictly domestic, in no case coming under observation, showed the parasites. The range of observation is, of course, too limited to form a basis for any conclusion.

Hair-worms.—Very recently, speaking of the occurrence of the Gordius, or Hair-worm, in our streams, there appeared an explanation of the widespread belief in the myth that hairs from the tails of horses are transformed into such worms. The experiments suggested may lead to some very curious conclusions concerning the physics of hairs. Microscopic examination of cross-sections of horsehairs may reveal what are the peculiarities of the cortex which cause unequal changes when moistened and thus produce writhing motions so similar to the muscular movements of Gordius. So deceptive are these mechanical movements of the hairs that one can readily pardon the belief that they are really transformed. Will not the microscopists follow up some lines of inquiry herein suggested?

Carleton College, *Oct. 10, 1888.*

A New Mode of Life Among Medusæ.*

By J. WALTER FEWKES,
CAMERIDGE, MASS.

Much has been written on the influence of parasitism in the modification of animal structure. Perhaps nowhere do we find this better illustrated than among certain of the Crustacea, where the anatomical structure is so masked by parasitic habits that for a long time in the history of research it was impossible to recognize their zoölogical affinities, and it was only when the immature stages in the growth were studied and larval conditions, unaffected by parasitism, had been investigated, that the true relationships of the group could be discovered.

It would seem that among the lowest animals we ought to find a larger number of parasitic genera than among the higher. While there is little doubt that there is more variety in lower animals, I am not so confident that this mode of life has led to as great modifications in structure here as might be expected.

Nowhere among lower animals is there more likelihood that we should find parasitic conditions than among the Medusæ. The young of a majority of these animals live attached to submarine objects, and it seems easy to see how, by changing its habitat, a parasitic attachment to another animal might easily take place. Considering the probabilities, however, although the number of genera which might be mentioned as living upon other animals is large, the number of recorded instances of those which have suffered a modification in structure by their attachment is very small.

Everyone who has taken a hand in dredging in the ocean knows how often ascidians, brachiopods, large mollusks, and other animals are brought up with attached hydroids growing upon them. These hydroids, in one sense, are not parasitic, as they draw no nourishment from their hosts, nor are they at all modified by their mode of life. For instance, Hydractinia, from a Natica shell inhabited by a hermit crab, is not unlike Hydractina from the underside of a floating bell-buoy. Obelia from the stalk of Boltenia is specifically the same as Obelia on a submerged log. In these and similar instances, for they are numerous and varied in nature, there is no resultant modification either of host or parasite, as the attachment is in no way vital or intimate.

There are, however, among the Medusæ, certain recorded cases of parasitism where there is a vital connection so to speak, where there is a parasitism, or even commensalism, of such an intimate character that not only the structure of the parasite, but also even that of the host itself is modified. It is a study of these cases which has a most interesting morphological importance, for it affords, in some instances, at least a means of estimating the modifications of structure which may result in Medusæ from parasitic habits. They introduce into the discussion of the theory of evolution a series of facts which may well be carefully considered by those who ascribe to selection an all-important factor in the modification of animal structure.

One of the best known instances of parasitism among Medusæ is that of Cunina which lives parasitic in the stomach of another Medusa, Geryonia. We, undoubtedly, have, in this case, a modification of the parasite by its peculiar mode of life in the host, although a reciprocal effect on the host is not recognizable.

A most interesting instance of parasitism, and consequent modification among Medusæ, is found in the problematical organism, Polypodium. This undoubted hydroid is found parasitic in the ova of the sturgeon while in the body of the fish. We have in Polypodium, as described by Ussow, a hy-

* From Proceedings of Boston Society of Natural History.

droid-like animal which develops and drops buds which can be directly compared with Medusæ. These are not the only instances of parasitic Medusæ thus far recorded, but they are typical and useful for comparisons. None of them are as valuable as they might be in estimating the amount of change in anatomy which has resulted, since we are either ignorant of their whole life-history or that of related adults with simple development.

It is with the greatest pleasure that I am able to add to the above-mentioned instances of parasitism among Medusæ another of most extraordinary character. This instance is peculiarly adapted for the study of the effect of parasitism in modifying the Medusan structure, as its close allies are well known and comparisons with them can be easily made. This instance is the first recorded example of a hydroid living attached to the outside of a fish, and modified in structure by its life.

In the pelagic fishing which has been carried on for the last ten years at the Newport Marine Laboratory we have taken several specimens of the well-known fish, *Seriola zonata*, Cuv. This fish is a close ally of the ordinary 'pilot fish' and is often seen in calm weather swimming near the surface of the sea. Three of these fishes were found in company last summer, and upon the side, near the anal fin, of one of these, curious appendages were noticed which had never been observed before. On capturing the fish and making a superficial examination of the attachment, I was reminded of an attached fungus growth. Everyone is familiar with the growth on fishes of the fungus Saprolegnia, and the resemblance seemed so great, except in color, between the supposed fungus of Seriola and Saprolegnia that at first I regarded the former as a fungoid growth. The color of the supposed fungus of Seriola was, however, reddish and yellow; and, although I have since learned that superficial fungoid growths of this color sometimes exist on fishes, at the time when Seriola was captured I was ignorant of this fact; the red color led me to doubt its fungoid affinities. A glance at the supposed fungus through a small lens showed me that I had a new and unique case of a parasitic hydroid.

As the genus of hydroid which shows this curious mode of life is new, it will be necessary to assign it a name, and I suggest that of *Hydrichthys mirus* as expressing one phase at least of the curious life which it leads. The majority of genera of Hydromedusæ have ordinarily two stages of growth, one of which is called the hydroid and the other the medusa stage. The latter is a medusa-form zooid of the former. Let us consider each of these stages.

Hydroid.—The hydroid of Hydrichthys consists of sexual and asexual individuals, both of which arise from a flat plate of branching tubes which is fastened to the sides of the body of the fish. The sexual individuals may be called the gonosomes, the asexual the filiform bodies.

The gonosomes consist of a simple contractile, highly sensitive axis, upon the sides of which are borne lateral branches with terminal clusters resembling minute grape-like bodies. These grape-like bodies are medusæ in all stages of growth. The filiform individuals are simple, flask-shaped bodies, without tentacles, and with terminal mouths.

No circle of tentacles about a mouth opening was detected either in the gonosomes or the filiform bodies. This is a significant loss, since, with few exceptions, tentacles of some kind are found near a mouth or in relation to the oral opening of most of the fixed hydroids or polyps.

Medusa.—The gonophore of Hydrichthys has a Sarsia-like bell and manubrium, four radial tubes, four tentacles without appendages.

In the light of what we know of the affinities of the medusa of Hydrichthys it is interesting for us to consider those of the attached hydroid. If our

problem was to determine the relationship of Hydrichthys from a study of the medusa alone, we could easily conclude that it is a near relative of Sarsia. Such a conclusion is one that can easily be defended. When, however, we come to compare the hydroid of Sarsia and the hydroid of Hydrichthys, we find the greatest differences between the two. These differences are so important that they have affected the whole structure; for a comparison of the two reveals the effect of the peculiar mode of life in Hydrichthys. The typical structure, or schema, of the tubularian hydroid, as Coryne, is a slender axis which may be naked or encased in a chitinous tube, an enlargement at the free end, and a terminal mouth opening. This mouth opening or the walls of the enlargement bear tentacles in rows irregular or otherwise. Somewhere among these tentacles, or elsewhere on the stem, arise buds which may or may not develop into medusæ. The widest variations from such a schematic type might be noticed among hydroids. Our purpose here is to compare Hydrichthys with the so-called schema.

In the case of the gonosome of Hydrichthys I suppose that the stem of the schema remains, that the terminal mouth opening is present, but that the enlargement of the axis has disappeared. From the sides of the axis arise lateral branches as in some hydroids and the medusa buds have been crowded to the distal ends of these branches. Tentacles have disappeared on account of the parasitic nature of the life of the hydroid. It is from this fact that we find in Hydrichthys the schema of the ordinary tubularian hydroid reduced to a simple sexual body or gonosome.

In the homology of the 'filiform bodies' of Hydrichthys the reduction, as compared with the schema of a hydroid, has gone still further on account of the parasitic life, and nothing remains but a simple axis without appendages of any kind.

If I am right in this homology of the two kinds of individuals in the Hydrichthys colony, it would seem as if there ought to be a meaning for their simple structure as compared with the typical hydroid. The relation of the medusa to that of Sarsia-like genera would imply degeneration, not phylogenetic simplicity. Cannot we find in parasitism a cause for such a degradation?

Is the conclusion legitimate that these great differences between Hydrichthys and the fixed hydroid closely related to it are the result of its peculiar mode of life? I believe it is. I believe that the modification in the hydroid Hydrichthys, the loss of tentacles, the polymorphism, and the increase in prominence of the sexual bodies, are exactly what we should expect to find *a priori* if a degradation had taken place in its structure.

The Seat of Formative and Regenerative Energy.*

By C. O. WHITMAN.

The question of the rôle of cytoplasm† is twofold. Is it merely passive and wholly at the mercy of forces either external or emanating from the nucleus, or is it self-active, automatic as well as acted upon?

A strong tendency now exists to refer all the changes in the cytoplasm to the agency of the nucleus. The purpose of the present article is to consider the regenerative and formative powers of the cell whether residing in the nucleus or in the cytoplasm, or in both, as a physiological unit.

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* Condensed from original article in *The Journal of Morphology*, vol. ii, part 1, p. 27.
† Cytoplasm is defined as the protoplasm of the cell exclusive of the nucleus.

Isotropy.—Pflüger, in 1883, tried to show that the direction of the cleavage planes in the amphibian egg was determined by gravity, and that the germ always gave rise to the same form because it developed under the same conditions. These claims must have been correct had the egg been not self-directive, but they have not been allowed, and by experiment the cleavage planes were proved to be while not independent of gravity, at least not primarily caused by its influence.

When this view, that the entire egg was merely passive, had been abandoned, writers such as Born (1884), Hertwig (1885), Wiesmann (1885), and Kolliker (1885) suggested that perhaps the nucleus was the directive part of the egg, but that the cytoplasm was purely passive. In this form the doctrine of Isotropy may be nearer the truth, but it does not express the entire truth. Its adherents cite in its favor the conspicuous part played by the nuclear bodies in the fecundation and segmentation of the egg; also, the incapacity for regeneration on the part of enucleate protozoa. Great light has been thrown upon the opposite view, that of the self-directive activity of the cytoplasm, by Van Beneden in his researches upon the development of Ascaris. The truth appears to lie between the two extremes in ascribing to both the nucleus and the cytoplasm a self-activity and a share in determining later events. One fact which tends to prove the participation of the cytoplasm is the presence in Clepsine of polar rings in the cytoplasm at the same time that nuclear phenomena are displayed. That the former is not caused by the latter is shown by the fact that they begin before the nuclear movements, and because they are unknown in other eggs, and for the second reason, that they are not due to pronuclear influences.

*Cytokinetic phenomena.**—These are numerous, and many of them are plainly associated with nuclear motions or karyokinesis. Whether any are independent or originate otherwise than in karyokinetic actions is not certain. The facts in the case are not sufficiently known to furnish a complete solution to the problem, but a few examples will be next examined.

The exit of polar globules is often attended by a considerable flattening of the egg, followed in some cases by a remarkable constriction which traverses the egg from the equatorial zone to the animal pole, finishing up with a nipple-like prominence from which the first polar globule is expelled. The second polar globule is sometimes accompanied by a similar but weaker cytoplasmic movement. This has been seen in Clepsine, Petromyzon, and certain Teleosts. Thus, here we find the expulsion of the polar globules a part of maturation to involve the coöperation of two factors—one karyokinetic and one cytokinetic.

Cytoplasmic movements are also observed in pelagic fish ova. In these the cytoplasm at first forms a zone of even thickness around the whole ovum. Upon the entrance of the spermatozoon this layer of protoplasm concentrates itself at one pole of the egg, and from it the germinal disk is formed with its centrally-placed male pronucleus.

The artificial division of infusoria has been resorted to in the attempt to show the relative importance of the nucleus. Nussbaum (1886) was first to show that enucleate pieces of infusoria were incapable of regenerating lost parts, while nucleate pieces soon regained their specific form. *The nucleus is thus indispensable to the preservation of the formative energy of the cell.* On general theoretical grounds, and because some of the Protista are enucleate, we are obliged to regard the nucleus as secondary in its origin. It may be that nuclear substance is present in such cells in a diffuse form, and that a later step is the coalescence of the nuclear matter into a single nucleus.

* Cytokinetic means concerned with movements or phenomena in the cytoplasm.

If it is thus a secondary body, it does not seem that we can consider it as in higher forms embodying the entire regenerative energy.*

While the study of the higher Protozoa seems to prove that the nucleus must be present in order to reproduction, certain facts from the lower Protozoa seem to require still further revision and study before we can regard the case from the Protozoa as settled. Thus, Graber (1883) finds that in Actinophrys, one of the heliozoa, the body may break up into parts without the concurrence of visible changes in the nucleus. The enucleate individuals behave as the parent did, but it was not learned whether they can generate a nucleus. They may coalesce with each other or with the nucleate individual. Actinosphærium, a multinucleate form, may break up and each part carry away a nucleus and the parts may reunite, the nuclei remaining distinct. Here, then, cytoplasm appears to have all powers except the power of reproduction.

It is further noticeable, as an indisputable fact, that there is no form-correlation between nucleus and cytoplasm. The nucleus, except during division, is usually spherical, and after dividing it returns to its spherical or oval form. It would seem that its influence should thus be equal in all directions, and enforce a similar form upon the cell. How different the cell! It preserves the spherical form, but very rarely. Variation in form is its most constant character. 'While the nucleus goes on repeating its form with never varying regularity, the cell marches straight on from form to form, never returning, never repeating, differentiating, developing, and adapting itself at every step to its environment and to the work it is destined to perform.' In a protozoan of varying form we are struck with the independence of outer body-form and the form of the nucleus.

The latter portion of the paper is occupied by a consideration of the nature of the force which is characteristic of living protoplasm, and may be called vital force. The writer deplores the prevalence of a conception of the formative power of protoplasm, which is merely mechanical, or like mechanical or chemical forces. Since a power which causes is not necessarily at all like the result produced, so the chemical and mechanical agencies at work in connection with protoplasm do not argue that the force manifested by living protoplasm resembles either chemical or mechanical forces. Rather it would, more probably, be unlike them, and peculiar, since protoplasm is unique. Further than this, towards a positive assertion as to the nature of the formative power in protoplasm, Prof. Whitman does not go, except to argue that it is a necessary attribute of the chemical substance, protoplasm. His words are these:—'The living cell may be regarded as a system of very complex chemico-organic units, bound together by chemico-physiological bonds, and displaying in their collective capacity functions and powers which are entirely foreign to them as individual and isolated elements, and which are, therefore, indissolubly identified with the physiological connexus or consensus.'

NOTICES OF RECENT ARTICLES.

The microbe of dysentery.—Chantemese and Widal report the discovery of a specific bacterium in dysentery (*Progrès Médical*, April 21, 1888). Working in Cornil's laboratory, they have studied five cases of tropical dysentery, and have found the same microbe in the lesions and stools of a fatal case, as well as in the stools of four others. The bacteria were found in colonies in and between the tubular glands of the intestine, in the lymph-glands, and

*On this point it may be observed that one who considered that in non-nucleated Protista the diffuse nuclear matter was the sole directive force would seem not to be inconsistent in holding the nucleus to be solely self-active when the nuclear matter was coalesced to form a single nucleus.—O.

in the spleen. The organisms develop rapidly at the ordinary temperature, thriving on all the usual culture media. They are bacilli with rounded ends, and somewhat thicker in the middle than towards the extremities. They grow luxuriantly in sterilized water from the Seine. Fed to guinea pigs, pure cultures produce intestinal inflammation and necrosis, the stomach itself being affected. The lesions are more marked where the gastric contents are rendered alkaline. Intraperitonial injections cause death in two or three days with peritonitis, pleuritis and pericarditis. The liver is affected in these animals, necrosis with colonies of bacilli being found in the portal areas. All these lesions in the experimental cases furnished pure cultures of the bacillus. From these facts and the absence of the bacillus in the fæces of healthy men, Chantemese and Widal feel justified in claiming specific properties for this bacillus. In commenting on this paper the *Medical News* says that, although the observations made are too few in number to bring absolute proof, they are of interest as being the first in which so much has been accomplished. Numerous other investigators have described micro-organisms in dysentery, but none, up to this time, have succeeded in cultivating them. (*Science*, Sept. 8, 1888.)

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Cholera.—Sir Joseph Fayer,* in a lecture at the Medical Society of London, says that, 'we seem to be warranted in stating the following to be facts with reference to the disease:—1. That cholera has been present in India from the earliest times, that isolated cases occur in almost all countries. 2. That cholera is always present, not only in certain parts of India, but elsewhere, and that in India outside these areas its prevalence varies in different years and according to the season of the year. 3. That cholera does not attack all places within an epidemic area. 4. Meteorological changes produce sudden alterations in the action and intensity of outbreak. 5. That the rate and direction of an epidemic are not influenced by facilities of communication or by the greatest streams of human traffic—the opening of the Red Sea route, for example, not having increased its diffusion. 6. That the cases are more frequent and more severe at the commencement than in the continuance of an outbreak. 7. That hygienic measures afford the greatest security, but are not an all powerful safeguard against cholera; local insanitary conditions and impure water favor its incidence and increase its intensity; that it is important to check all diarrhœa in times of cholera prevalence. 8. That cordons and quarantine have utterly failed to prevent the spread of cholera, but on the contrary have done harm. 9. That to enter an area over which cholera is present, or to travel within that area, is especially dangerous to a new-comer, while residents, whose circumstances of living are favorable, have a better chance of escape. 10. That removal is the best course when cholera attacks a regiment or other body of men. 11. That attendants on the sick have not suffered more than others. 12. That impure water, irritating articles of diet, unripe fruit, and saline apérients are liable, during cholera prevalence, to bring on diarrhœa and the disease. 13. That fatigue, exhaustion, fear, and anxiety are powerful predisposing causes. 14. Many circumstances attending the outbreak of the disease and the pathological conditions then developed seem opposed to a specific poison as being the cause of the disease. 15. Having suffered from cholera gives no immunity from recurrence of the disease.

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Saccharine or Tar Sugar.—Dr. O. A. Kennedy states† that tar sugar, the extract from coal tar products, which is estimated to have 280 times the

* Lancet, May 19, 1888.

† *American Practitioner*, vol. vi, p. 167.

sweetness of cane sugar, has only recently been investigated with reference to its therapeutic qualities. The substance is extracted by a very intricate process in which sulphuric acid is employed. The Council of Hygiene of the Seine at Paris has investigated the effects of this sugar upon the human system. It is found to be antiseptic, paralyzes the bile secreting activity of the liver, is not assimilated as a food, and is liable to produce and aggravate gastritis. While these results are not reported with the degree of exactness which a physiologist would expect, still they seem to argue against the use of saccharine. In addition, it is stated that a man in sound health may not take more than a grain and a quarter per day with impunity. It is possible that the presence of unremoved impurities causes the ill effects of saccharine. If they belong to the 'sweet' itself, then it will be useless to expect to find here a substitute for cane sugar.

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Nucleus in Oscillaria and Tolypothrix.—D. H. Scott* contributes the result of studies upon the nucleus in the 'blue-green' algæ and differs from the general assertion that these are separated from other plants among other characters by reason of the lack of nuclei. He is not the first one to prove the point, Zacharias having recently shown a nucleus present in yeast, *Oscillaria* and *Tolypothrix*. Scott prepared his specimen as follows:—5 minutes in methylated ether (mixture of methyl alcohol and ether), 4 minutes in Kleinenberg's hæmatoxylin, mounted as usual in Canada balsam. In the middle of each cell a deeply stained rounded body is seen, which has a distinctly fibrous structure comparable with the knot stage of the ordinary nucleus. A second mode of preparation was this:—two hours in picro-nigrosin solution followed by immersion in saturated solution of chloral-hydrate for two minutes, finally mounting in glycerin. The observations are figured, and leave no doubt of their truth in spite of the weight of authority asserting the absence of nuclei from schizomycetes.

EDITORIAL COMMENT.

By HENRY L. OSBORN,

HAMLINE, MINN.

American Journal of Morphology.—The second volume of this publication has appeared and fully maintains its very high standard of excellence. It is entirely safe to say that it is not inferior to any biological journal published. The printers leave no point for dissent in the paper or typography, and the plates are many of them printed in Germany.

Of the articles it can be said that they are of the highest excellence and will demand the attention of all investigators. One of the articles, a contribution to cytology, or the mechanism of the animal cell, by the editor, Professor Whitman, is reproduced in abstract in this number of the JOURNAL. The original article, however, should be read if possible. It is a source of pride that the venture, for such in some degree the *Journal of Morphology* must have been, has not proved a failure. The number of subscribers to such a publication is necessarily small, and the expense of its production very great. Every well-wisher for the cause of Animal Morphology who can afford to do so may show his sincerity by becoming a subscriber.

* Journal Linn. Soc. 1888, p. 188, vol. xxiv.

The Tuberculosis Congress.—This convention held in August in Paris has established certain facts regarding the disease. To a Frenchman, Dr. Villemin, is awarded the credit of having discovered that the disease is caused by a living organism. His position was strengthened by the researches of Koch upon the organism. The disease, it is now believed, first attacks animals whose flesh we eat or milk we drink. The disease was shown to be common among the cows of France where they are not well protected against inclement winter weather. It was asserted by some that danger from infected meat was averted by boiling. But this was not proven in general. The work of the congress seemed to be to prove some undoubted facts with reference to the nature of the disease, but not to contribute especially to the knowledge of its cure.

It is to be observed, however, that the meeting is to be regarded as by no means a failure because the cure was not discovered. The mere fact that the single disease was thoroughly discussed is highly encouraging to the cause of medicine. As the history of science teaches, and it is one of its best lessons so well pointed out by Professor Langley in his address before the American Association, the path to ultimate discovery is never one of continued steps in advance without errors, but rather that a great mass of errors and false steps have to be taken before the truth is really entered upon.

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Yellow fever germs.—Prof. Sternberg, who is as well informed as any one in this country, recently read a paper upon the yellow fever. He denies that any of the claimants have yet discovered that germ, after having experimented very carefully with it in the manner described by them. He has proved that the blood of yellow fever patients contains no specific disease germ. In Havana he had abundant opportunity for experiment, and there turned his attention to the alimentary canal. Here he found several micro-organisms not before recognized, any one of which might prove to be the germ of yellow fever. At present his researches have gone no further than this point, but he will continue them. Biological science will yet find the cause of this and other such diseases and the means of cure or prevention.

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The Hatch bill appropriation.—It is entirely natural to expect that, as a result of the expenditure by the United States Government of $15,000 per year in the agricultural schools of each State, some valuable and interesting scientific results should have been forthcoming. There are at least two of the States which seem likely to fulfil this expectation. In Connecticut Prof. W. O. Atwater will make experiments with a view to determining, if possible, whether the plant body can use free nitrogen in the manufacture of albuminous molecules. This question has long been considered, though it has been suspected that plants do have the power in some degree of using free nitrogen. In New York Prof. Comstock is preparing to experiment upon insect growth. He has a laboratory building with space for experiments; besides this, two conservatories or 'vivaries' for rearing living insects. One is to be kept at the temperature of the outer air, and the other at any desired temperature. He is also having an apparatus made for observing insects that live on roots of plants, and other ingenious apparatus for insect study. In all the States the money given by this bill should be used in economic research.

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Biology economically applied.—There was a very good investment made in Minnesota during last August. Prof. Otto Lugger, State entomo-

logist, learned that in certain sections of the State the chinch bug had made his appearance in such numbers as to threaten to cut short the income of the agriculturists. Realizing the danger, he stopped the ravages of the bug very summarily. Earlier in the season he had experimented at the State farm upon a fungoid disease of the chinch bug, and had found that, by propagating the disease, he could kill the bugs as fast as they matured. With his stock of diseased chinch bugs on hand he awaited news of the pest. Then he distributed diseased bugs. These communicated the disease to their fellows, and the bugs succumbed in immense numbers. It is probable that the grain saved by this ingenious device (simple enough when understood and applied) will be worth the salary of many State entomologists and experimenters for many years to come, even if they were to do no further service. Prof. Lugger has promised soon to publish an account of the disease.

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The Biological Section of the American Association.—At the recent meeting this section was not so fortunate as might be desired. The attendance was limited largely to botanists and entomologists, and there was a scarcity of papers. At the British Association, meetings of this section are made very interesting indeed. Might not American biologists well introduce such general discussions as the British did in the case of the coral island question? Physiological topics are legitimate as well as morphological ones, though the former seem to predominate. A greater variety of topics treated, and the attendance of representatives of all departments of biology, are the points to be immediately considered by those who have been elected officers for 1889.

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Oleomargarine.—This topic forms the subject of a very full report in the Nineteenth Annual Report of the Massachusetts State Board of Health.* It is written by Dr. E. G. Brackett, of the Harvard Medical College. He shows, by reference to statistics, that the production of oleomargarine in that State is an industry of considerable magnitude, and thereby justifies a thorough examination of the matter. He describes the process of manufacture, considers its relation to health, and shows that, at present, comparatively little is fraudulently sold as butter. The paper seems to show conclusively that oleomargarine has nearly as high a nutritive value as butter, that it keeps far better than butter, and that it is no more likely to be uncleanly or unwholesome than condensed milk or any other manufactured food. It is, therefore, to be regretted that popular prejudice still regards it as an adulteration to be avoided. Its price and nutritive qualities justify its use as a substitute for butter. There is now every reason to suppose that it will, in time, appear under its own true name, upon its merits, like packed eggs, stale butter, salt herring, and other foods which are common enough and not under any excluding ban.

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The Galapagos Islands.—These were visited by the U. S. Steamer Albatross in her exploring cruise, and Prof. L. B. Lee, of Bowdoin College, one of the naturalists on board, has given in the New York *Evening Post* a brief account of the colony there. One of the largest islands, 600 miles from land and under the equator, is the home of 150 persons. The islands are out of the line of commerce, hence communication is nearly impossible. The numbers are recruited from time to time from the criminal classes of Ecuador. Male and female are about equally numerous. They seem to have

* Boston. Wright & Potter. pp. 93. 1888.

no religion. A marriage ceremony is not considered necessary, and a state of nature seems to prevail which the anthropologists would find an interesting subject for study. The governor (or autocrat by virtue of his superior strength) has a sort of dependence upon the government of Ecuador, but he rules despotically and maintains his position by a miniature standing army. The islanders raise sugar-cane and make rum from it. They export fruits, hides, mats, and orchilla. The latter is a moss from which a valuable dye-stuff is obtained.

NOTES.

Prof. A. H. Tuttle, formerly of the Ohio State University, Columbus, Ohio, has recently become professor of biology in the University of Virginia. His wide experience, both as a student and a teacher, and his skill, particularly in microscopical research, will fit him well for his new position.

Clark University, at Worcester, Mass., has secured as its president Prof. G. Stanley Hall. In his letter of acceptance he intimates an intention to depart widely from the traditions with reference to the character of the institution, and a purpose to institute a new style of instruction which shall cause it to take a very high rank among the colleges.

M. Pasteur has suggested a scheme to relieve the Australian government of the rabbits, now become a serious pest in that country, by introducing among the rabbits an infection of chicken cholera. It is soon to be given a trial in New South Wales.

Deaf-mutes, according to figures collected and published by Prof. A. Graham Bell, are rapidly on the increase in this country. The effect of taking young deaf persons and housing them together in asylums is that they intermarry, and one-third of the offspring of these intermarriages are born deaf and dumb. The consequence of this, if unchecked, will be the establishment of a deaf and dumb variety of the human race.

The number of physicians in Siberia is said to be in some districts only one to every one hundred thousand inhabitants. Does this speak well for the health of the people, the skill of that single, lonely practitioner, or does it speak ill for the government of Russia?

Ptomaines and Leucomaines, or the putrefactive and physiological alkaloids, by Victor C. Vaughan and Frederic C. Novy, is a complete survey of a subject on which Professor Vaughan is especially entitled to speak. The authors are of opinion that many diseases, at present investigated as to their ætiology upon bacteriological lines of research, are really caused by poisonous products, the result of tissue metabolisms which are not excreted from the body as they normally should be.

Distance of the sun and moon.—Prof. Wm. Harkness, of the U. S. Naval Observatory, has just completed an extended piece of work, in which data never before brought together have been used, and which has resulted in giving, with far greater accuracy than ever before, certain figures.

The data used consisted of the following:—

1. All observations that have ever been made as to the size and figure of the earth.
2. All observations that have been made for determining the force of gravity.
3. All observations upon the velocity of light.
4. All observations upon the positions of the stars.
5. All observations upon the positions of the sun and moon.
6. The observations upon Venus and Mars.

The net result of calculations involving all these elements gives the sun's parallax as 8.8357 $\pm$ seconds. The figures 8.83 are now settled beyond all possibility of dispute. Future research can change only the thousandth figure. From the above parallax he gets the sun's distance from the earth as 92,521,000. (The transit of Venus result was 92,385,000.) He gives the moon's parallax as 3,422.724 $\pm$, whence its distance from the earth is 238,852.4 miles, and the moon's mass is 1–81,519. The velocity of light is 186,298.4 miles per second.

Easy method of printing from negatives.—A curious experiment, which any one may try, has recently been described by Mr. J. W. Osborne, of Washington, D. C. The key to it is in the fact so often observed by every one that newspapers, being long exposed to light, turn brown. Take a stencil, or any perforated sheet of metal, place beneath it such paper as some newspapers are printed on, and on both sides put pieces of glass. Expose it to the sun's rays 48 to 60 hours. A print that can be easily seen will be found upon the exposed part of the paper. For paper, substitute a *freshly-planed* surface of white pine; the print will be very legible upon sufficient exposure. Passing a hot iron over the surface, after printing, serves to bring out the characters more plainly. Tinfoil is a very good substance to use for making perforations of the shape one desires to reproduce by this printing process.

Sticky postage stamps.—During a recent week of continuously damp weather a subscription agent sent a letter containing 90 cents in stamps that, upon receipt, were so stuck together as to render their acceptance undesirable. If stamps are folded between slips of tinfoil they may be sent with perfect safety in damp weather, may be carried in vest pockets, and even immersed in water, without injury. A clerk in the Patent Office washes the gum off his stamps as soon as he buys a lot, carries them in his pocket with impunity, and mucilages them as fast as he wants to use them. The tinfoil that tobacco chewers throw away will obviate all this trouble.

Hay Fever.—Dr. Morell Mackenzie, in his monograph on this complaint and its treatment, says, that among races, the English and American; among classes, the upper and cultivated; and of the sexes, the males are especially susceptible to hay fever. In the north of Europe it is almost unknown. It is rare in France, Germany, Italy, and Spain; whereas in England it is frequent, and in America prevalent. Again, 99 per cent. of its martyrs are of the upper class, while agricultural laborers, who are most exposed to the causes of the complaint, are least subject to its attacks. Lastly, the male sex is more liable to it than the female, in the ratio of three to one. He gives its cause—'the entrance into the eyes and air-channels of those predisposed to the ailment of minute particles of vegetable matter from grasses and plants in flower'—and its cure, chiefly cocaine in one form or another.

QUERIES.

Q. 1. How can dissections of butterflies, crickets, and other common insects be preserved until wanted for mounting?—F.

A. Perhaps there is no better way to effect this than to place the specimen in a glass vial containing a mixture of equal parts of 95% alcohol and glycerine.

Q. 2. What are the details in mounting them permanently, and in what are they best mounted? For illustration, a butterfly's tongue and a cricket's gizzard.—F.

A. In mounting a butterfly's tongue, treat the specimen, after dissection, in a covered watch-glass, with absolute alcohol, then with turpentine, and, finally, with benzole balsam. The gizzard better be cut open lengthwise in order to display the teeth, and then be mounted directly in glycerine jelly. The balsam will make the teeth nearly invisible.

N. B.—These answers are not the result of any experiment on our part, and perhaps some correspondent can suggest better methods.—O.

MICROSCOPICAL SOCIETIES.

ESSEX COUNTY, N. J.—F. VANDERPOEL, *Secy.*

September 28.—The annual meeting was held at the residence of Rev. F. B. Carter, Montclair. After the adoption of the Treasurer's report, which showed the finances to be in a satisfactory condition, the following officers were elected:—

President, Morgan W. Ayres, M. D.; Secretary, Frank Vanderpoel; Treasurer, J. S. Brown, M. D.; Executive Committee, Rev. F. B. Carter, Dr. Geo. S. Allan, Mr. J. L. Smith.

A vote of thanks was accorded the retiring President, Dr. Allan, for the faithful performance of his duties during the year. The members may honestly congratulate

themselves on the success which has attended their efforts during the whole period of existence of this organization. Not only have prominent microscopists appeared before the Society with instructive and entertaining lectures, but the members themselves have done much excellent work, and have shown that there is enterprise and enthusiasm enough among those whose only time to use the microscope is in the evening to make for the organization a name among the working societies of the country.

NOTICES OF BOOKS.

A Preliminary Contribution Toward a History of the Fresh-Water Infusoria of the United States. By Alfred C. Stokes, M. D. Trenton, N. J. 1888.

The character of Dr. Stokes's work in the systematic study of the infusoria is already well known, since it has been in the pages of this and other periodicals that a large part of the descriptions of new species have been published. This publication of the Trenton Natural History Society contains a complete exposition of the present state of knowledge of the group treated. Its thoroughness entitles it at once to a place among the 'Authorities' on this subject. It is one of the books the zoölogist who works this department must have. It describes in full all American species, and mentions by name all European forms found in this country.

Dr. Stokes, who is not a professional naturalist, but one who has found in biology a secondary occupation, has added to our knowledge in this department three new families, twenty new genera, and two hundred and forty-three new species, and yet he is very conservative and not given to making new species on slight provocation. The total number of species, genera, and families described is very much larger than the above since it includes all native American forms. The amount of labor involved in this kind of work is very great, both because of the restless nature of the animals when under examination, and more especially from the difficulty of finding particular forms when needed. But such labor is highest pleasure to one who has crossed the border line of first experience and has really become initiated.

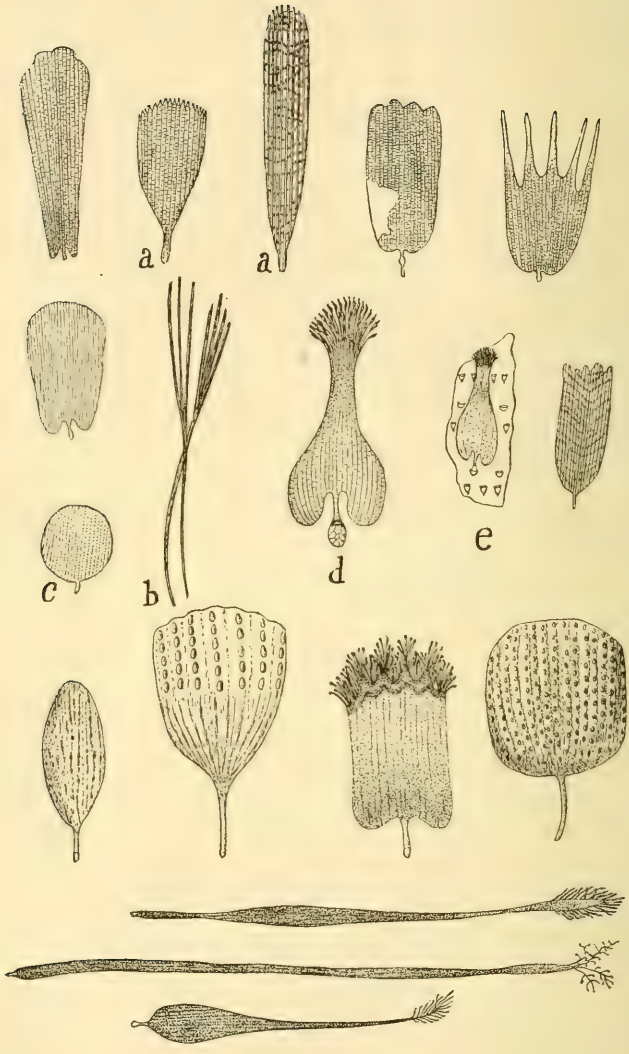
Report on a part of Northern Alberta and Adjacent Portions of Assinboia and Saskatchewan. By J. B. Tyrrell. Montreal. Dawson Bros. 1887. 175 pp. and maps.

Northern Alberta is the part of British America just north of Idaho, and the districts of Assinboia and Saskatchewan lie east of Alberta. This report of the Canadian Geological and Natural History Survey gives an account of the surface geology, including soils, vegetation, ore, coal-beds, etc.

The district is a vast tract capable of extensive improvement, and of supporting a large population like Manitoba. Enormous deposits of coals and lignites underlie an area of 12,000 square miles, and, taking as a guide the thickness of the bed at an exposure at Bow river, the deposit would yield 9,500,000 tons per sq. mile. The coal is alleged to be 'equal in quality with that of Colorado and Wyoming.' Iron is reported, but not as a valuable deposit. Some traces of gold are mentioned in the beds of many of the streams. Clays are abundant for plastic purposes, but good building stones are not present. The report contains a detailed narrative of the survey, with careful description of the various features of the district. It would lead us to infer a condition very similar to the western part of our own country, where farming, on the most extensive scale, is made to pay well. If so, there certainly is room enough. Over-crowded England can find here a convenient outlet for her multitudes. The Canadian Pacific Railroad will doubtless do much toward settling this vast and, at present, undeveloped territory.

Mound Builders' Works, near Newark, Ohio. By Isaac Smucker. 16 pp. 1888.

This little pamphlet is dedicated by the friends and patrons of the Licking County Pioneer Historical and Antiquarian Society to the members of the American Society of Microscopists as a reminder of their visit to the mounds at the close of the Columbus meeting last summer. The substance of it was also published in the *American Antiquarian* for July, 1888. It gives a very interesting description of the pre-historic monuments of Licking county. Its dedication is an appreciated mark of kindness towards the microscopists who visited Newark in August.—C. W. S.



SCALES OF BUTTERFLIES AND MOTHS.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL.

VOL. IX. **DECEMBER, 1888.** No. 12.

All communications for this Journal, whether relating to business or to editorial matters, and all books, pamphlets, exchanges, etc., should be addressed to American Monthly Microscopical Journal, Box 630, Washington, D. C.

European subscriptions may be sent directly to the above address accompanied by International Postal Order for $1.15 per annum, or they may be sent to Messrs. Trübner & Co., 57 Ludgate Hill, London, accompanied by the yearly price of five shillings.

Microscopical Work for Amateurs.*

BY ALFRED C. STOKES,

TRENTON, N. J.

The work of a man who lived nearly 200 years ago has suggested some things that can be done to-day with far greater ease, but with much profit. It is said that 'A good workman can do good work with poor tools,' but not many workers in science, art, or any handicraft like to use such tools. Still, it is the patient care and perseverance that yield beautiful results. Do not those who are forced to use imperfect implements deserve more credit than those who show fine work with fine tools? In the Dutch city of Delft a workman in science was born in 1632. It is supposed that he had not many school advantages; and if this is true, what he did, notwithstanding his limited education, demands still greater praise than the good work he accomplished with poor tools. But very little is known about him until he began to make discoveries with his microscope.

His name was Autoon van Leeuwenhoek (pronounced Lüh-wen-hook), a name that every modern microscopist knows and remembers. He was chiefly a microscopist, and he is worthy of remembrance, not exclusively by reason of his original microscopical discoveries, but because he made his own microscopes. Every instrument that he used he made with his own hands. Before he could begin the work he wished to do, he was compelled to make the tools with which to work. When they are compared with the splendid instruments of the present day, they have no value except as curiosities; but two centuries ago they were better than the best used by other investigators. What modern microscopist would be willing, or what one would be able, to grind and polish a little globule of glass, and to mount it in brass-work of his own manufacture, simply to gratify his wish to know some of nature's secrets? But this old Dutch microscopist did that, and he did it well; for, miserable as his microscopes were, with them he saw more and better than could any of his fellow microscopists.

As Leeuwenhoek labored and studied by methods of his own in that Dutch city of Delft, his published articles were exciting the scientific world, and

* For the use of the illustrations to this article we are indebted to the Science Publishing Company, which has kindly loaned them for the purpose.

setting scientific men by the ears; but he would never tell how he made his microscopes. To all inquiries he said only that he made them, refusing to

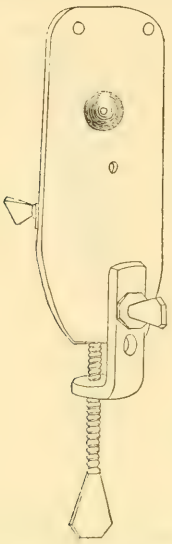


FIG. 1.—Front.

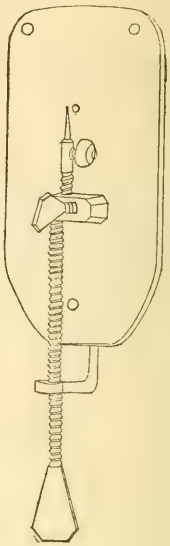


FIG. 2.—Back.

LEEUWENHOEK'S MICROSCOPE.—Natural Size.

go into particulars. He was cautious, too, about showing them, evidently fearing that they might be copied and, perhaps, surpassed. He willingly showed them only to such prominent personages as Peter the Great, who visited him in 1698, and to Queen Mary, who also went to see him. Leeuwenhoek's cautiousness, however, made other scientific men angry, and they accused him of caring more for praise than for the truth of his discoveries.

It was only after his death, in 1723, that the secret of his microscopes was learned. He bequeathed to the Royal Society of London 26 of his instruments, which were examined and described; but the descriptions are almost as poor as we now consider the microscopes to have been, giving erroneous ideas about them, and some incorrect pictures. Curiously enough, all of these 26 microscopes mysteriously disappeared from England. A few are still to be found in Germany, and one of these was not long ago exhibited as a scientific relic before the Royal Microscopical Society of London.

In an unusual burst of confidence Leeuwenhoek once said:—'Indeed, I have hundreds and hundreds of microscopes;' but exactly what he meant was not understood until he was dead. Then it was learned that he had been in the habit of making a microscope for every object he preserved. At the present day a microscopist considers himself fortunate if he owns one good instrument, but Leeuwenhoek had as many as he had mounted objects. The specimen to be examined was fastened behind the lens, and when once prepared to his satisfaction was not disturbed, but was always ready for instant use. Judging from his discoveries, it would seem that the Dutch investigator must have labored day and night to have done so much, yet he lived to a good old age. His success goes to prove the truth of the saying about the good workman with poor tools, for his discoveries have stood the tests of time and of our modern instruments.

In figs. 1 and 2 are shown, natural size, the front and back of one of Leeuwenhock's microscopes. Each of his microscopes was formed of two

oblong thin metal plates riveted together, clamping the magnifying lens between them near the upper margin. As the plates were sometimes made of silver, we may suppose that it was choice, not necessity, that induced him to make his own optical tools; as a rule, however, they seem to have been of brass. On both sides of the glass lens the plates were pierced by a round hole not larger than the head of a small pin. The eye, when about to examine an object, was placed close to the microscope, so that it could look through these holes and through the lens at the specimen on the opposite side as the instrument was held in the hand and towards the light. On the back, as shown in fig. 2, there is an upright, pointed rod just opposite the lens. On this the object to be studied was fastened, usually by being pressed against a little piece of wax, and the focus was obtained by raising or lowering the rod by the long screw shown in fig. 2; the smaller one near the centre of the metallic plate being used to remove the object from the lens, or to bring it nearer. When the parts had been properly arranged, Leeuwenhoek studied the specimen by gazing at it long and earnestly through the little lens which his own hands had made. His success is due to his inexhaustible patience, his tireless study, and to his skill in understanding and correctly describing the thing he saw; with such magnifying glasses he must have seen the objects very imperfectly and indistinctly.

In the following paragraphs are enumerated a few things which no human eye had ever seen until the eye of this old Dutch microscopist saw them. Some of his discoveries are so well known, and have so generally become the common property of students, and they refer to so common objects, that it seems as if even beginners in microscopy ought never need to learn them. Those who have used the microscope much can scarcely remember when they learned about some of these things, and the modern student often feels surprised when he hears that what he may see almost anywhere, and at almost any time, were unknown to the more advanced observers of natural science in the seventeenth century.

Among his discoveries which readers are least likely to know about is one in reference to the eggs of the common muscle (*Unio*) which every boy has found in the mud of shallow streams. Leeuwenhoek was the first to learn that it lays eggs, the first to see the young muscles within the egg, and the first to discover that these little unhatched animals do not lie quietly inside the delicate egg, but that they are continually turning round and round. He was himself so surprised by this continuous motion, that he wrote:—'This uncommonly pleasing spectacle was enjoyed by myself, my daughter, and the engraver, for three whole hours, and we thought it one of the most delightful things that could be exhibited.' To this day it is a delightful thing to see under the microscope, and the owner of an instrument, with even a low-power lens, can see something very like it at almost any time during the spring or summer, and in the winter, too, if he keep an aquarium with a few water-snails in it. This rotation of the young inside the egg is not confined to the eggs of the muscle. Those of any water-snail will show it beautifully. Snails' eggs are plentiful in any pond. They are to be found attached to floating chips or submerged logs. To the naked eye they resemble an oblong or rounded mass of colorless jelly, perhaps an inch, or less, in length, with many little dark spots scattered through it. These spots are the very young snails within the delicate eggs which the jelly surrounds and protects. In fig. 3 is shown a jelly mass of this kind, about the natural size, the scattered black dots representing the young snails as they appear to the naked eye. The jelly is quite firm, and can be scraped off with a knife-blade. It may be placed in a deep cell for microscopical examination. Then each egg will appear with the young snail within it, somewhat as is shown by fig. 4.

where a single one is drawn. The little unhatched creatures will continually glide round and round within the imprisoning egg, often turning about to travel in the opposite direction, and sometimes rolling completely over. The sight is, indeed, as Leeuwenhoek said about the young *Unio*, 'one of the most delightful things that could be exhibited.'

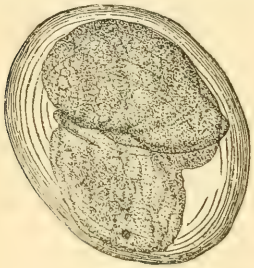


FIG. 4.—Embryo of Snail.

FIG. 3.—Egg Mass.

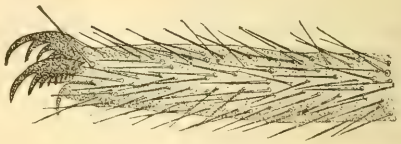


FIG. 5.—Spider's Foot.

Many of Leeuwenhoek's discoveries are interesting to scientific people only, anatomists caring for some, botanists for others (for he studied plants as well as animals), but there is one that is pleasing to all. This refers to the scales on the wings of butterflies and moths. The fine dust that clings to the fingers when the delicate wings of these insects are touched is formed of innumerable scales, whose shape varies in different butterflies, and whose color is the cause of those charming tints which ornament the filmy wings of the airy creatures. A little piece of a wing snipped off and examined as an opaque object will show these beautifully formed and gorgeously colored scales lying over the whole surface like the shingles on a roof, one row slightly overlapping the row below it; and a little of the dust scraped away and placed on a glass slip will, under a low magnifying power, be revealed as separate forms of wondrous beauty. Often the wings of the same butterfly, or moth, will bear scales of several different shapes, while the forms obtainable from butterflies of different kinds vary greatly in outline. In the plate seventeen forms of scales are shown, including some from the common gnat, and the too common clothes-moth. Their exquisite color cannot be shown in a black-and-white engraving, but the peculiar shapes are faithfully preserved. Curious as these seem, some are from butterflies that flit abundantly through the summer air, others are from rarer specimens.

Leeuwenhoek also first saw the very minute scales on the common gnat. In the plate two of these are shown, marked *a*, *a*. These, in their natural state, have very little color, scarcely more than a silvery sheen. The same plate includes three scales, two marked *b*, one *c*, both of which are from the clothes-moth, the almost circular one, *c*, being from the under surface of the wing. The one marked *d*, with its curiously elongated heart-shaped outline, the fringe on the upper margin, and the stem with its terminal bulb on the opposite end, is from the common cabbage butterfly, while sketch marked *e* shows how these scales are attached to the wing, the little bulb on each one snugly fitting into a cup made to receive it. Notice that there are two kinds of cups. This is explained by the fact that there are two forms of scales on the same wing, which necessarily call for two kinds of cups to hold them in place.

Leeuwenhoek did much work among insects, dissecting them to study their microscopic anatomy. He discovered that insects' eyes are not simple or single, but that each is composed of many, like the eye of the house-fly. While examining spiders he was the first to see the organs called the spin-

nerets, from which issue the threads to form the web. He also discovered the spider's poison-glands, and the peculiar, comb-like arrangement of the claws. These toothed claws are shown magnified in fig. 5, with a part of the spider's hairy leg. By some it is supposed that these combs are used by the spider to cleanse her body; others think that they help in the weaving of the web.

The people of that time seem to have been painfully ignorant. Among other notions which now appear laughable was the belief that cochineal was the dried fruit of a tree; and until our Dutch microscopist examined this queer fruit and decided it to be a dried insect, nobody seems to have thought of questioning the popular theory. He believed in using his eyes, and when they failed him over the minute things of nature he made a microscope and brought that to his aid. His eyes were the first to see that each human hair is solid, not the hollow tube that everybody then supposed it to be. While those thoughtless people believed that fleas could be formed from a little heap of moist dust in a warm place, he proved that such a thing is impossible, for he discovered that fleas lay eggs. The common muscle, too, was believed to be formed from the mud it lives in, but Leeuwenhoek laughed at such an idea. He said that if so small an animal as a muscle could be made from a handful of mud so could a whale, but that he did not believe in any such foolishness. Then he set to work to find the muscle's eggs and succeeded.

It is neither possible nor desirable to mention a hundredth part of this famous man's discoveries. The purpose in selecting those here referred to is to point out for the encouragement of the amateur microscopist a few attractive objects, and to show him that an abundance of microscopical work, important work too, can be done with what may seem to be a very poor outfit. It is not so much the tools that make the result, as it is the perseverance and energy and brains behind the tools.

REPORTS OF RECENT ARTICLES.

The Growth of Jelly-fish.—Dr. W. K. Brooks, in the September and October numbers of the *Popular Science Monthly*, presents a review of the morphology of certain of the Hydromedusæ, which is of far greater interest than much of the popularized science because it states the result of the latest researches of a great morphologist with regard to the Hydrozoa. The two articles make a fascinating chapter in zoölogy brought easily within range of every intelligent reader. The purpose of the articles is to show the meaning of the hydroid stage in the life-history of Hydrozoa. It was once supposed that the Hydroid was an adult animal; later, it was noticed that free medusæ arose from many; that some exhibited a hydroid condition of great elaborateness and a medusa stage of but slight comparative duration. Dr. Brooks argues from the case of *Cunina* that the hydra stage of the animal is to be regarded as a larval stage of a former developmental history which it rapidly passed through to reach the adult free-swimming medusa condition. That circumstances have in the cases of some of the descendants of such an ancestor made it favorable for them to remain longer in this larval condition, and even to specialize from it several forms, as the feeding protective root and blasto-style polypes of some very complete colonies, and even in some instances to remain in the larval stage permanently and not develop into the medusoid stage at all. This view of the matter gives satisfactory value to all the varied forms of hydromedusæ as no other view of the meaning of their difference has done.

Mr. S. H. Barbour, in the *American Journal of Arts and Sciences* for October, p. 227, notes some observations upon a young two-headed tortoise, *Chrysemis picta*. The creature has its body of the proper shape, but has two distinct necks and heads. The two heads exhibit complete mental independence, being characterized by different dispositions, and the muscular system of one side is directed by the head of the same side, while breathing in the two is independent. One side may be asleep while the other is awake and inclined to move, in which case only the legs of one side move. Hunger may strike the heads singly, or a combined attack may happen; in the latter event, selfish endeavors for chosen morsels are observable. Differences may arise which are settled only by recourse to warfare between the two heads. The monstrosity is interesting as showing mental unlikeness where the post-natal environment has been similar for two individuals.

Report upon the Postal Club Boxes—I.*

By QUEEN MAB.

The character of the contents of the boxes of the Postal Club is usually miscellaneous enough to afford something of interest to every member of the Club. The imperfections of a slide as well as its perfections may often be made a source of instruction. Criticisms will be made only with this object in view.

Box X^2 is just received. Slide No. 1 is contributed by Jas. A. Close, of Summerfield, Ill., '*Trichina spiralis* encysted in muscle of Albino Bat.' The muscle was placed for a few hours in $\frac{1}{4}\%$ chromic acid, then transferred from weak glycerine to less dilute, and mounted in Price's glycerine. The slide was re-mounted at headquarters, and is one of the best finished slides in the box.

No. 2, by C. H. Lavenell, of Englewood, Ill., is 'Raphides of Juice from *Tradescantia*.' The contributor suggests that the plant receives its name, spiderwort, from its mucilaginous juice, which is capable of being spun out into a very fine thread. These crystals make a very fine polariscope mount. The slide should be whirled on the turn-table while the cut end of the plant is pressed upon it.

No. 3 is Cirrhosis of Human Liver, by C. E. Hannaman, of Troy, N. Y. It was hardened in chromic acid and alcohol, cut in freezing microtome, tinted with eosine, and the nuclei stained with hæmatoxylin. Then it was transferred from clove oil to dammar.

Nos. 4, 5, and 6 are contributed by T. B. Jennings, of Lebo, Kansas, and are, respectively, 'Louse of Mallard Duck,' 'Parasite of Grasshopper,' and 'Foot of *Tabanus bovinus*.' These were soaked for a few days in carbolic acid, and mounted in either dammar or balsam. A critic suggests that the parasites, like all objects of a similar character when soaked in carbolic acid, have a greasy appearance, showing plenty of shadow, with but little of structure.

*In previous volumes of this periodical there appeared numerous reports of this character, but of late none have been published. Indeed, some new subscribers lately inquired how the Club was organized, which led to the explanation given in the July number under the head of Queries. A friend who has furnished this report promises their continuation, but modestly declines to be known to the public. The publisher has therefore christened this writer Queen Mab, and may, perhaps, be allowed to forewarn, in metaphor, the preparers of slides for the Club boxes in the language of Herrick:

'If ye will with Mab find grace,
Set each platter in its place;
Rake the fire up and set
Water in ere sun be set,
Sweep your house; who doeth not so,
Mab will pinch you by the toe.'

Notes on Diatoms and other Algæ of New Haven Harbor and Adjacent Waters.

By WM. A. TERRY,
BRISTOL, CONN.

In July and August, 1887, I spent several weeks in a thorough and systematic search for diatoms along the eastern shore of New Haven harbor, extending my examination throughout Morris Cove, the channel and mouth of the harbor, and beyond the light-house and breakwater several miles out into Long Island Sound, and to other points both east and west, including creeks and tide-pools of the salt marshes. The apparatus used in collecting consisted of a small scoop-net with a pocket of lawn muslin fixed at the end of a long and light pole for use in the creeks and tide-pools, and a light dredge, made of similar material, with about one hundred and fifty feet of stout line, for use in deep water. The material procured by the use of this apparatus was generally rich in living forms, and contained also the shells of former generations, thus showing not only the varieties then in active life but those of other seasons whose time had passed. I shall not attempt to give a complete list of varieties found as I am unable to determine a large proportion of them, and experts to whom I have sent them do not agree. Besides, a mere list of names would swell this paper beyond its proposed limits; but I will give a partial list of the more prominent and numerous species.

The tide-pools in the salt marshes back of Fort Hale were especially rich in *Pleurosigma balticum* and *Navicula cancellata*, and contain also numerous *P. angulatum*, *P. fasicola*, and other pleurosigmas, some of which were so delicate as to be almost invisible in Canada balsam; several varieties of *Navicula constricta*, *N. elliptica*, *N. lyra*, large and small varieties of Coscinodiscus, Actinoptychus, Amphora, Amphiprora, etc. In a previous article in this periodical I mentioned finding *B. paradoxa* plentiful in these marshes. At this time I failed to find it here. Looking in the locality named by Miss Booth about the same time, near the New Haven Depot, I found only a few and feeble specimens, but found them abundant and vigorous in the deep water at Morris Cove.

In the moat around Fort Hale were found, in addition to many of those above mentioned, varieties of *Achnanthes*, *Melosira*, *Cocconeis*, and many others. *P. balticum* was found also abundant in the salt marshes at Pawson Park, off Branford; in the creeks and tide-pools at Milford, Conn.; and this season I found them in like quantity in the marshes of the lower part of Boston harbor, and in the shallow water at Nantasket landing.

P. angulatum I found universely distributed in all parts of New Haven harbor, and in all other places investigated on the Connecticut shore. It was entirely wanting in the gatherings in Boston harbor.

Morris Cove is a nearly semi-circular indentation in the eastern shore of New Haven harbor, extending from Fort Hale to Light-House Point, a distance of about one and a half miles. It has a smooth, sandy beach of sufficiently abrupt descent to admit of bathing at all hours, and at a few rods distance from the low-water line there is a sand-bar thrown up by the waves. On this the water is so shallow that the little steamer that sometimes runs from New Haven cannot approach the pier at low tide, and has to land its passengers in row-boats.

In this cove I found the diatoms arranged in narrow belts or zones. First at the low-water line were small *Amphora*, *Amphiprora*, *Nitzschia carvula*, *N. sigmoidea;* several kinds of *Pleurosigma*, some of which became more plentiful in deeper water; many kinds of small *Coscinodiscus* and

other minute discoid forms. At the bar the small Amphora were replaced by much larger varieties. *Navicula lyra* were plentiful, showing many variations; also many other *Naviculæ* of similar form. Beyond this a *Pleurosigma* resembling *P. formosum* predominated. *Baccillaria paradoxa*, in large groups and in ceaseless motion, was more plentiful than I have ever found it elsewhere. Next came a *Pleurosigma* resembling *P. balticum*, but very much smaller, being less than half its length and diameter and somewhat easier of resolution, in sufficient quantity, so that I made a nearly pure gathering. This form had a more rapid motion than the large *P. balticum*. Through all these different belts were scattered *P. fasicola*, *P. attenuatum*, *P. elongatum*, *P. acuminatum*, and several others; *P. angulatum*, as before stated, extending throughout the entire region. *Navicula constricta*, *N. elliptica*, and many other species were also present in great variety. The water here was about fifteen feet deep and beyond this the diatoms were not arranged in such well-marked divisions. From this point to the channel of the harbor I found *Coscinodiscus*, *Actinoptychus*, *Triceratium*, *Auliscus*, *Campylodiscus*, *Scoliopleura*, *Eupodiscus argus*, *Stauroptera aspera*, and many other species, in large and small varieties, more or less abundant. Outside of the light-house and breakwater was a deposit of soft mud, extending for a considerable distance, which contained many of the above forms, and beyond this was a hard bottom from which the dredge brought up nothing but sand and shells. The search was extended for several miles out into the Sound and for a considerable distance east and west without success, leading to the conclusion that this part of the Sound was comparatively barren. In Milford creek or inlet, near the town wharf, I found many of above species, and *Surirella febigera* and *S. gemma* were common; *Rhabdonema* and *Biddulphia* were abundant, and *Hyalodiscus subtilis* appeared as large as the Californian specimens. A small form, which I should call a *Stephanopyxis*, was also common. In all these gatherings were many species and varieties that I do not attempt to name. An occasional *Actinocyclus* was found. This season I have found in Dike creek, near Morris Cove, *Actinocyclus* in abundance, all the *Pleurosigmas* before mentioned, with several others, and two large varieties new to me. They are as large as the largest *P. balticum*, one of them being heavier than that variety; and the other is more graceful in form and much more active. It is the most tenacious of life of any of that species I have ever seen. Higher up this creek a very large *Nitzschia* is plentiful.

This season, September, 1888, I found *B. paradoxa* in large groups plentiful and active in a ditch in the salt marshes south of Morris Cove. Although in constant and rapid motion they were covered with parasites. A small diatom was numerous, and a filamentous growth covered some groups, so that when the line was contracted it resembled a caterpillar. This section was very rich in varieties, many of them being entirely new to me; but I have not yet had time to give them a thorough examination. Last year, August, 1887, I first found *B. paradoxa* very active and vigorous among the branches of a specimen of *Polysiphonia violacea*, which was picked up off the beach at Morris Cove. The previous week an oyster steamer had been dredging near the mouth of the cove, and now the water at the beach was brilliant with red algæ, beautiful specimens of *Grinnellia americana*, *Dasya elegans*, various *Polysiphonia*, *Ceramium*, *Callithamnium*, etc., being plentiful. These varieties are not usually so common on this beach, but for many years I have collected off and around Fort Hale all these, and also *Bryopsis plumosa*, *Spyridia filamentosa*, *Chondriopsis*, *Lomentaria Baileyana*, which are very common, and the fiery scarlet *Griffithsia Bornetiana*, rare here. Very large plants of *Grinnellia americana*, with fif-

teen and twenty fronds attached together, are often found, and I have picked up *Dasya elegans* of such size that a card-board at least four feet square would have been required to lay it out properly.

At the mouth of the harbor and on the opposite shore we find *Ectocarpus* growing on *Fucus nodosus*, with many varieties of *Ceramium*, *Callithamnium*, *Chondriopsis*, etc. At Hines' Point, *S. filamentosa* is more robust than at Fort Hale, and brighter in color; *G. americana* is more slender; here and at Merwin's Point, also, are *Chordaria divaricata* and *C. flagelliformis*, *Champia parvula*, etc.

I have examined these sea-weeds for diatoms, but have found little except various *Melosira*, *Synedra*, *Rhabdonema*, *Cocconeis*, and other small or filamentous forms.

From Light-house Point eastward, beautiful specimens of the red Algæ are often found. *Dasya elegans* here grows stouter and is more densely clothed than that growing in the harbor. This type generally dries a sepia brown when mounted, while that from Fort Hale is often pink or crimson.

During still and pleasant weather, with moon in perigee, at low tide soon after sunrise, before the steamboats have begun running to stir up the sediment, *Grinnellia Americana*, *Dasya elegans*, and other choice specimens may be seen growing off Fort Hale on boulders at the bottom of six to ten feet of water at lowest tide. This is an unusual sight, as these varieties generally grow in too great depth of water to be seen, and are only to be found when brought in by tidal currents, after having been torn off by marine animals that feed upon them. They are seldom thrown upon the beach, but float along in the tidal currents, and are best procured by wading. I have frequently brought in a larger number of specimens at one tide than could have been procured during an entire season from those thrown upon the beach.

The Metamorphoses of the Dog-Flea.*

By W. J. SIMMONS.

I invite attention to the metamorphoses or embryonic changes of the dog-flea. The insect is common enough, and troublesome enough; and yet the careful observance of its transformations needs a little maintained application and forethought, and is not to be despised as a training for those higher flights on which I trust some of us will shortly venture, with the view of endeavoring to trace out the life-history of the mango weevil. There is perhaps no more common object in cabinets than a mounted flea; some may own half-a-dozen different kinds of mounted fleas; but it may be doubted if the possessors of these cabinet museums ever take the trouble to follow a single flea through the four stages of its life, or to observe for themselves how very different the full-grown insect is from himself in a previous state of existence.

Those who have done so will assuredly say it is far more profitable to trace the life-history of one of these minute pests than merely to mount slides of a dozen kinds. According to the *Micrographic Dictionary* there are no less than 25 different species of fleas. The dog, cat, fowl, marten, rat, squirrel, hedgehog, mole, pigeon and bat have each their own species. Two species of flea devote their hungry lives to the study of the rat, and three to that of the bat. One species, a vegetarian, is found in brush-wood, and another, a lover of mushrooms, *Bulex boleti*, is said to infest the boletus, a fungus like the common mushroom. I would ask you to make a permanent mental note of these last facts, because they may throw light on the genealogy of the

* Read before the Microscopial Society of Calcutta, March 5, 1888.

whole flea tribe. Then we have one species, *P. irritans*, which attaches itself specially to man himself, though of course it only selects the dirtier classes of men. I should, perhaps, add the Jigger or Chigoe to my list; it also is a species of flea. Packard speaks of it as "one of the most serious insect torments of the tropics of America."

You will see from all this that any one who wishes to get together as many different fleas as he can may secure at least two dozen slides while he is about it. I would suggest that he should make drawings of the five tarsal joints of his various specimens, for here he will find some unexpected differences of minute structure. For example, taking them in the order of greatest length, the tarsal joints in the anterior legs of both the cat and dog-flea would be registered 5, 2, 1, 3, 4; but in the cat-flea the posterior joints would be 1, 2, 5, 3, 4, while in the dog-flea they would be 1, 5, 2, 3, 4. Moreover, the dog-flea is adorned with a distinctive collar, a pectinate fringe on the pro-thorax, the badge, we may suppose, of his order; and in addition to this he wears a row of formidable brown *setæ* on the lower part of his head, both of which characteristics are wanting in the cat-flea. Now, these are not quite such small matters as they seem. For one thing, they show how materially the forms of two fleas, which infest two different but closely associated domestic animals, are subtly affected by their surroundings and habits and the general conditions of their lives. Here, then, is matter for instructive reflection furnished by the different fleas in a microscopist's cabinet. Believe me gentlemen, if you merely treasure up your objects for exhibition to friends and don't yourselves seriously *study* them, your specimens will not be a whit more useful to you from a scientific point of view—even though you actually need a good microscope for their exhibition—than would be a collection of postage stamps or of military regimental buttons. Indeed, in these hard times, stamps and buttons would be preferable, because the mania for collecting them would save you at least the cost of a microscope. In the event, too, of a re-sale, I venture to affirm that a good collection of postage stamps would be sure to realize a higher price than—two dozen old fleas.

To proceed, the notes on which this paper is based are taken from my diary for 1886, and refer to observations then made on some fleas' eggs which were deposited early on the morning of the 17th October, 1886. You will find a sketch of one of the empty egg cases amongst the drawings in fig. 2 of the book I now hand round. If you spread a cloth, a *jharun* is what you want, and let a dog sleep on it, you will find with the help of a pocket lens that the dust, etc., which he leaves behind him includes fragments of cuticle, hairs, fibres, and above all, nits and minute pellets of dried blood, which are probably the natural excreta of the flea. I dusted such a cloth on to a sheet of paper, and roughly separating the eggs and blood pellets from the other materials present, put the former into an ordinary finger-glass, which I covered with a broken pane of glass. On the morning of the 19th October, about 50 hours after deposition, most of the nits had hatched out, though a few took a day or too longer. The period of incubation, therefore, for the larger number of eggs collected by me, was a trifle over two days. The larvæ were white, cylindrical, active grubs. Their bodies seemed to me to be in 13 segments, exclusive of the head. The larva is eyeless; and according to Packard, the shape of its head, its habits of living in dirt, its movements, and its transformations are held to ally the flea to the Mycetophilids, a group of fungivorous, two-winged flies, which are endowed, like the flea, with considerable leaping power. Kindly bear in mind in passing what I said about the flea which is found in brush-wood, and that other flea which affects a species of mushroom. Fleas, though formerly placed in an order by themselves, *Aptera*, are now

regarded by the best authorities as an aberrant family of *Diptera*, or two-winged flies. I should remind you here that the word *Aptera* means wingless, while the word *Diptera* means two-winged. Though fleas do not now possess wings, you will see that naturalists have placed them among the two-winged insects, because in classification more attention has been recently paid to the life-histories of organisms, and to the genetic affinities which exist between them, than was given to these matters before it was seen that unsuspected relationships subsist between creatures which in adult life appear to differ materially from each other.

To resume my description of the larva of the flea, each segment of its body is beset with long hairs; Packard tells us there are four to each segment. The head has a horny scale or shield on each side and bears two three-jointed antennæ, which are very unlike the antennæ of the mature flea. The terminal segment ends in two curved spines, which probably aid the larva in moving forward. You will find drawings of all these parts in my sketch-book. The larva I had under observation fed on the pellets of congealed blood which, as I said, were deposited with the eggs. Packard affirms that the larvæ of the cat-flea live on decaying vegetable substances—a not unimportant fact, perhaps, in its bearing on the history of fleas. The larvæ of the dog-flea reared by me were supplied with no food besides blood pellets; but though I never caught them at it, I sometimes suspected that they practised gross cannibalism on the sly; certainly their numbers thinned without any apparent cause, and as they lay at the bottom of a covered finger-glass, up the steep sides of which they could not climb, it is difficult to account for their disappearance.

On the 25th October, the seventh day after they left the egg-case, I found them curling up and edging off from the masses of dried blood; and supposing they might be about to moult or to pupate, I placed a small fragment of *puttoo* in the finger-glass as a kind of hospital comfort. Eyeless though they were, the larvæ quickly swarmed into it, and there they spun little white silken cocoons. In my note for the 25th October, 1886, I find this record:—'The writer in *Science-Gossip* had a difficulty in rearing his larvæ, and lost them when they were fit for the pupa stage. It is clear he missed this necessary addition to their comforts.' In my own case several larvæ were already dead when I placed the *puttoo* in the glass. A more recent observer writing to the same useful little journal, *Science-Gossip*, recommends flea larvæ being placed on woollen cloth when about to pupate, so that what I did before he published his observations is evidently the correct thing. The pupæ were visible in most of the cocoons and were decidedly flea-like in form; they looked like rough wax life-size models of fleas, with enough of the mummy thrown in to convince one they were still pupæ. On Tuesday, November 2, 1886, most of them quitted their cocoons as perfect, active fleas. My brood were, therefore, in the egg for, say, 50 hours, larvæ for six days, and pupæ for eight days; in other words, they completed their metamorphoses in a trifle over sixteen days, attaining their adult state on the 17th day after the eggs were deposited. Westwood, cited by Packard, says fleas are larvæ for twelve days, and that the period of pupation varies from eleven to sixteen days. Westwood also seems to consider that they may even hibernate in the larval state. It is quite possible that the periods vary in different climates, perhaps even at different periods of the year. There obviously are marked differences between the periods given by Westwood and those observed by me in Calcutta; but as I watched the brood closely, and recorded all my notes at the time of observation, I think what I have said may be accepted as correct for Calcutta at the season at which I worked.

A few remarks in closing as to the significance, from a wider point of view, of these and similar insect transformations. What, briefly, is their import?

May not they be rightly regarded as 'the doctrine of evolution shown in small before our eyes?' The growth of the individual, whether it be a flea or one of ourselves, is a specimen of the growth of the race. An increasing number now hold that these metamorphoses are 'only explicable on the hypothesis of a really existing relationship among organized beings of widely differing classes.' These, of course, are speculations which would lead us into vast fields of controversy, which had better be avoided in an elementary paper like this. At the same time do not let us forget that there are lessons to be learned from the observation of insect metamorphoses of more momentous import than the mere recording of times and seasons. Amongst ourselves I know there are some who feel it impossible to assume that the most primitive of fleas was precisely what we find his lineal descendants in the direct line to-day; who cannot, with the facts of nature before them, believe that each of the twenty-five distinct species of flea hopped into being ready made and independently of antecedent organisms. Nay, more, we do not believe that the earliest of *flea-like* insects did so. Others of our number would doubtless reject these views, but from what we know of each other, we are confident that none of us will lose our tempers or pronounce the ban of excommunication against the rest of his fellow-members. But while this is so, I strongly suspect that outside of our little circle there still are persons who would almost prefer a mythic origin for every organism to any which savored of the 'fancies of modern science,' as they are termed by well-meaning people who, though they may have been specially trained in logic and the humanities, yet fail to practically realize the wide distinction between a scientific hyyothesis and a mere fancy. To be logical on their lines we should, I submit, speak of the theory of gravitation as the 'fancy of gravitation;' the atomic theory should be 'the atomic fancy;' the wave theory of light, 'the wave fancy of light,' and so on. I should not hesitate to believe there are good people whose prejudice against evolution is so pronounced that they would even greatly prefer a grotesquely marvellous beginning to any scientific origin of species. Now, I have unearthed a theory for the creation, of the first of fleas, which ought to satisfy the most decided of anti-evolutionists. It will assuredly save them all further inquiry after that unnatural caricature of 'a missing link' which is the one thing needful from the non-evolutionist's point of view. My story possesses the additional recommendation of having been first started amongst the simple-minded nomadic patriarchs of Kurdistan. Could a more convincing argument be urged on its behalf? Hear, now, how the Kurds account for the flea and—certain other vermin thrown in rather promiscuously, from a scientific point of view:—'When Noah's ark sprang a leak by striking against a rock in the vicinity of Mount Sindshar, and Noah despaired altogether of safety, the serpent promised to help him out of his mishap if he would engage to feed him upon human flesh after the deluge had subsided. Noah pledged himself to do so, and the serpent, coiling himself up, drove his body into the fracture and stopped the leak. When the pluvious element was appeased and all were making their way out of the ark, the serpent insisted upon the fulfilment of the pledge he had received; but Noah, by Gabriel's advice, committed the pledge to the flames, and scattering its ashes in the air there arose out of them fleas, flies, lice, bugs, and all such sort of vermin as prey upon human blood; and after this fashion was Noahs' pledge redeemed.'

Now, is not the fact that fleas, when they have the chance, still prey on human blood, irresistible proof of the truth of the simple, child-like story which I have just narrated? Leaving this important point to be decided by the anti-evolutionists, let me conclude in the words of Kirby and Spence:—'Don't you like fleas? Well, I think they are the prettiest little merry things in the world. I never saw a dull flea in all my life.'

Notes on Histological Technique.

By GEORGE C. FREEBORN, M. D.,
INSTRUCTOR IN NORMAL HISTOLOGY IN THE COLLEGE OF PHYSICIANS AND SURGEONS, N. Y.

A Selective Stain for Connective Tissue.—The dye employed is one of the aniline dyes, known in commerce as nigrosine, induline, or aniline blue-black. It comes in two forms, one soluble in water, the other in alcohol. The first variety is the one used. The quality of this dye varies greatly; with some samples I was unable to obtain any constant results, but with the nigrosine obtained from Dr. Grübler, in Leipsic, my results have been uniform.

The staining fluid is prepared as follows:—To 45 c.c. of a saturated aqueous solution of picric acid 5 c.c. of a 1 per cent. aqueous solution of nigrosine are added. This makes a dark olive-green fluid.

Sections of tissues, hardened in any of the usual media, are placed in the staining fluid from water, and allowed to remain in it for from three to five minutes, the exact time depending upon the thickness and density of the sections. They are then removed and washed in water until their color changes from a yellowish-green to a deep blue.

The sections are now dehydrated, cleared in oil of cloves, and mounted in Canada balsam. The oil of cloves is to be preferred for clearing as it dissolves out the celloidin, which stains deeply with the dye, and, if allowed to remain in the sections, detracts from the sharpness of the picture. Or, after dehydrating, the sections are stained for from five to six minutes in a mixture of 1 c.c. of a saturated alcoholic solution of eosin and 49 c.c. of 97 per cent. alcohol, then cleared and mounted in balsam. A too prolonged action of the eosin-alcohol will remove the primary stain from the finer fibres of connective tissue.

Sections stained by the first method show all connective tissue fibres stained bright blue, nuclei blackish, all other elements greenish-yellow. In the second method the yellow color is replaced by red.

Carminic Acid.—This dye was first recommended by Dimmock* as a staining agent for histological work in place of carmine, the varying quality of the latter rendering it very unsatisfactory. Dimmock used it in a $\frac{3}{4}$ per cent. solution in 85 per cent. alcohol; stained sections in it for two to five minutes, and, after clearing, mounted in balsam. If a pure nuclei stain was wanted he washed the sections in a 1 per cent. aqueous solution of hydric chloride.

I have found this dye when used in the following manner an excellent stain for ganglionic cells:—Sections of the central nervous system are overstained in Dimmock's solution and then washed in a 10 per cent. aqueous or alcoholic solution of the officinal solution of the chloride of iron. In this fluid the color of the section changes from a deep red to black, clouds of color being given off. As soon as the section begins to show a yellowish color it is transferred to a large dish of water, washed well, dehydrated, cleared in oil of origanum, and mounted in balsam.

Sections treated by this method show the nerve cells and their processes stained black, the intercellular substance yellowish.

Macerating Fluid for Nerve Cells.—Thin slices of the spinal cord, cerebral cortex, or cerebellum, not over one-sixteenth of an inch thick, are placed in fifty times their volume of a 5 per cent. aqueous solution of potassium chromate for twenty-four hours. At the end of this time the gray matter will be found to have become jelly-like in consistency and quite transparent. It is to be cut away from the white matter and the bits placed in a long, narrow tube—a Mohr's burette with the lower end closed with a cork answers the purpose perfectly. The burette is then filled up to within one inch of the

* Proceed. Soc. Amer. Natrl. of the Eastern U. S., Amer. Nat., xviii, p. 324.

top with fresh macerating fluid, and a cork forced in until it comes within half an inch of the surface of the fluid, thus leaving a small amount of enclosed air. The burette is now inverted and the bubble of air travels slowly up through the fluid, gently shaking the bits of tissue and freeing the nerve cells from the adhering intercellular substance. This manipulation is repeated at intervals of half an hour until the bits of tissue become reduced to powder. The burette is then placed in an upright position, and when the material has all settled the fluid is poured off. The material is now washed several times with distilled water by the method of decantation, and finally poured into a conical precipitation glass and allowed to settle. The water is then poured off, and the material stained by adding a solution of ammonia or picro-carmine. The staining requires from twelve to fifteen hours. After the staining has been accomplished the material is washed several times with distilled water, and finally preserved in a mixture of 1 part alcohol and 3 parts glycerine.

By this method of agitation the force applied is so slight that the more delicate processes of the cells, which are broken off by the more vigorous force used in the usual methods, are preserved. I have succeeded with this method in isolating cells from the spinal cord and cerebellum with the processes attached down to the fourth divisions. With the cerebral cortex my preparations up to the present time have not been as successful.

A Substitute for Corks in Imbedding.—The soaking of the corks in dilute alcohol used for coagulating the celloidin renders them so soft that they have a tendency to give before the microtome knife. If we try to overcome this difficulty by tightening the screw of the clamp, the cork is apt to bulge on its upper surface, thus loosening the specimen.

As a substitute for corks, we are now using in the laboratory what are known as 'deck plugs.' These are cylinders of white pine one inch high, and varying in diameter from one-half inch to one and a half inches. They may be obtained from any manufacturer of barrel bungs.

These 'deck plugs' are used in the same manner as the corks. They may be written on with a lead pencil, thus enabling one to label his specimens and keep a number in the same bottle of alcohol.

Intestinal Worms in Cats.

By F. BLANCHARD, M. D.

In this section of the country observation tends to show that cats are commonly infested by intestinal worms. Nearly every household has from one to five cats, and it is rare to see a fat, glossy, healthy specimen. On inquiry it is generally learned that a large proportion of the sickly ones are 'troubled with worms.' This is not theoretical, but is proved by the frequent vomiting of entozoa by the sick cats. The symptoms produced in the cat by the presence of intestinal worms are a restlessness and uneasy manner, a voracious appetite, frequent vomiting, and occasional attacks of epileptiform convulsions. The worm most commonly noticed is *Ascaris mystax*, but *Tænia* also occurs.

Five years ago the writer killed a sickly cat and made an immediate post mortem. In the small intestine were found four tape-worms (species undetermined), and twenty-four specimens of *Ascaris mystax*. The tape-worms were folded upon themselves longitudinally, and in one place must have produced nearly complete obstruction of the intestinal canal.

Peacham, Vt., *Nov.* 10, 1888.

Foster's Physiology is now being reissued in a fifth and enlarged edition. The first part has already appeared, and covers the ground of Book I, the vascular mechanism of former editions.

Parietal Eye in Young Petromyzon, Adult Petromyzon, and Myxine.*

By J. BEARD.

In ammocœtes, the larval form of Petromyzon, the parietal eye is hemispherical in shape, the lens being nearly flat and the retina and nerve-ganglionic layer being curved. The eye is overlaid by connective tissue and the membranous parietal bone, which in turn is covered by an epidermis of columnar cells. The lens portion of the eye is slightly enlarged in the centre. Its cellular structure is not perfectly discerned. The retinal portion is composed of very obvious rod-shaped structures which have their free ends toward the cavity of the eye opposite to the pattern of the paired eyes of vertebrates. The deeper portions of the rods are lost in two rows of rounded nucleated bodies believed to be nerve-ganglion cells. In some species the lower ends of the rods are surrounded with abundant black pigment; in others they are almost destitute of it.

In the adult Petromyzon the position of the organ is marked externally by a whitish spot in the skin due to the absence from that spot of the usual black pigment of the epidermis. The parietal eye usually lies in a deep depression and is pigmented, but if it is not pigmented in its retina it then lies in a shallow depression, or the depression is wholly absent. The organ in the adult, as in the young Petromyzon, lies beneath the membranous roof of the skull. It has besides the rods, as in Myxine, organs like the cones of the paired eye.

In Myxine, though from very poor material, the author describes a flattened two-layered organ, connected by a stalk with the brain. The hinder wall of the organ is a retina in which rods are distinguished and figured. The nuclei of these cells lie close to the cavity of the eye (in Petromyzon they are at the opposite end of the rods). In the specimens examined no retinal pigment could be found.

The writer had hoped to determine some points in the phylogeny of this remarkable organ by its study in the young Petromyzon, but he proves very little. He cannot think that it is one of the series of lateral sense organs as are the paired eyes and ears. He also regards with disfavor the idea of Spencer, that it may have been derived from the eye of the larval truncate, because the truncate seems well proven to be only a degenerate offshoot of a possible ally of the original vertebrate stock. The structure of the retina proves the eye to be unlike the paired type in its mode of development. He thinks, however, that the eye has developed in connection with the paired eyes, because the fibres from it run to the optic thalamus, and because in Petromyzon both rods and cones form the terminal organs.

A speculative suggestion as to the origin of the parietal eye is ventured:— That the paired eyes were once structures opening dorsally on the surface; that the parietal eye did not at that time exist: later the paired eyes were shut in together with the rest of the central nervous system, and the paired eyes were beneath the skin. At that time the paired eyes would receive light both through the side skin and through the median suture of closure. The side portions of the outer skin became set off as the lenses, and beneath them the sensory epithelium as the retinas of the paired eyes. The part of the sensory epithelium beneath the median line remained for a time as the pineal eye. The remainder of the former sensory epithelium aborted. This utilization of part of the sensory epithelium of the paired eyes is paralleled in the organ of Jacobson in Reptiles, and which arises from a portion of the olfactory epithelium.

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* Abstract from a paper in the *Quarterly Journal of Microscopical Science*, 1888.

Experiments with Chitin Solvents.*

By T. H. MORGAN.

Dr. Loop in the *Zoologischer Anzeiger* (1885, p. 333) stated that Labaraque solution (potassium hyperchlorite) or Javelle solution (sodium hyperchlorite) would completely dissolve the hardest chitin parts of insects, so that they can be sectioned or so that staining fluids will penetrate them. The author, in 1887–'88, made some experiments, the results of which he records as follows:—

It so happened that the first experiments were made upon the eggs of the common cockroach, and the selection turned out to be a fortunate one. Many eggs are laid at one time surrounded by a stiff chitinous coat forming the so-called raft. Two principal methods were employed—one using the commercial fluid full strength, the other diluting it five or six times. Rafts were placed in the weak Labaraque solution, left in till the chitin became soft and transparent, taking, if the solution were *slightly warmed*, from thirty minutes to an hour. If embryos are advanced, they may now be taken from the envelope one by one. If still young, they had better be hardened and cut all together. In either case the embryos after washing were transferred to picro-sulphuric acid, thence through alcohol to 95 per cent., then imbedded in paraffine cemented to the slide, and stained 'on the slide.' Corrosive sublimate or chromic acid were also used, but with less satisfactory results. The embryos transferred directly from Javelle solution to alcohol were nearly as good as those put through picro-sulphuric acid.

To specimens already hardened and preserved the solvent may also be applied, but where material is obtainable fresh it should preferably be treated immediately.

In most cases the object should be stained on the slide after cutting, but if the object be small it may be stained *in toto* after the chitin has been dissolved.

The only difficulty met in using the Labaraque solution is that it not only attacks the chitin, but also the soft tissues, apparently the connective tissue. Thus the joints of insects' legs, unless great care be exercised, will fall apart. But this difficulty can be met by removing the animal before the solution has gone far enough for this, and by diluting the solution. The only time when the strong solution can be employed is when the chitin wholly invests the substance to be cut. While this method will not serve in every case where chitin prevents cutting of tissues, it can be extensively employed to overcome difficulties heretofore insuperable.

NOTES.

Baldness.—For the benefit of those who have discarded the 'stiff hat' from fear of baldness after all the recent utterances on that subject, it is interesting to note from *Popular Science Monthly* the remark that the Parsees of India are compelled to wear during the day a hat tight enough to crease the scalp, and a skull cap at night, and yet he has never seen or heard of one of them who was bald.

Mr. S. H. Scudder, of Cambridge, Mass., will shortly publish a monograph on the butterflies of the Eastern United States. He has spent many years in its preparation, having announced it in 1869. It will be illustrated with very numerous plates of the adults, caterpillars, eggs, nests, etc.—in all 2,000 figures. The work of printing the plates has been in progress for 3 years. It is to be out in January, 1889.—*Science.*

* From Biological Studies, Johns Hopkins University, vol. iv, p. 217.

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